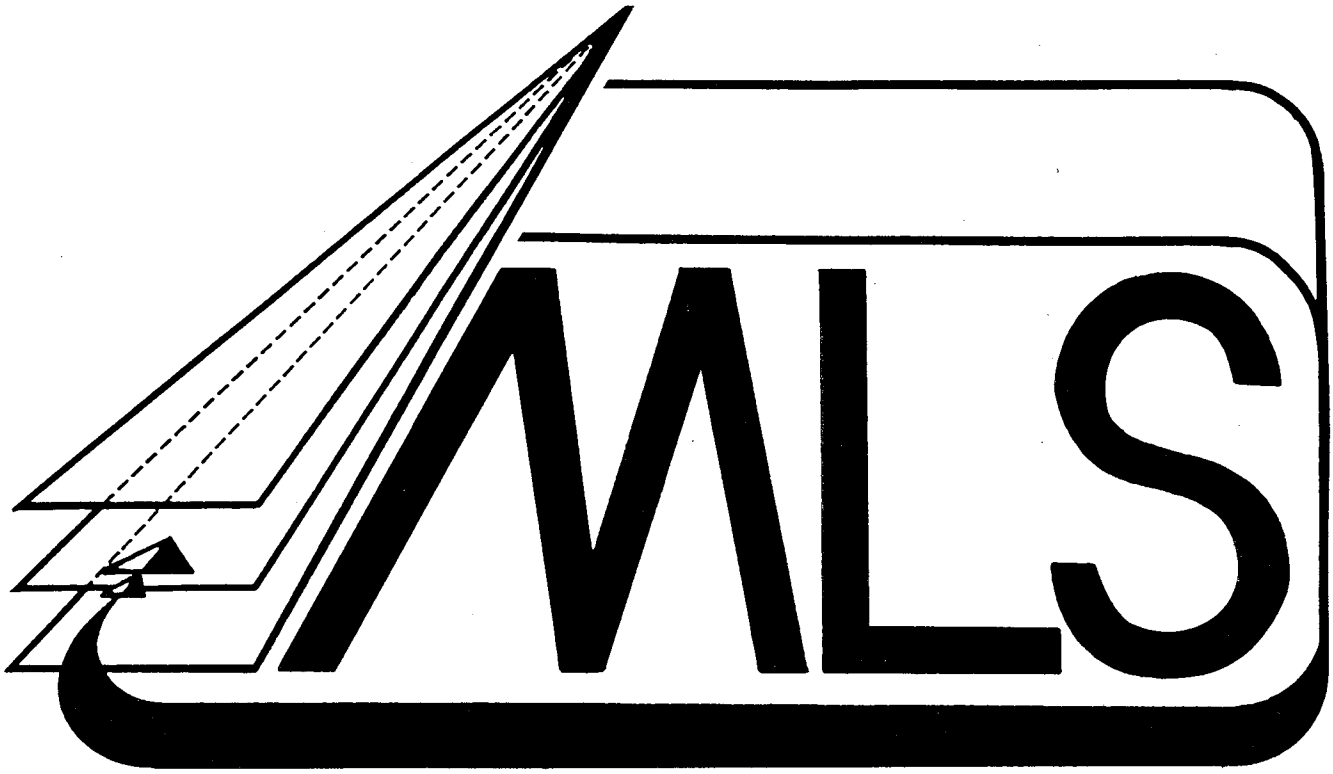


Microwave Landing System Indoctrination Handbook

Department of Transportation
Federal Aviation Administration

September 1985

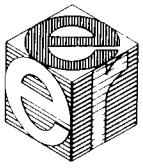
MICROWAVE LANDING SYSTEM (MLS) INDOCTRINATION HANDBOOK

Contract No. DTFA01-85-Y-01007

Prepared for

Federal Aviation Administration
Program Engineering and Maintenance Service

by



Engineering and Economics Research, Inc.
1951 Kidwell Drive
Vienna, Virginia 22180
September 1985

Second Printing by
MSI Services, Inc.
600 Maryland Avenue, S.W. Suite 695
Washington, D.C. 20024
May 1986

Foreword

This document contains five Chapters and Appendices. Chapters 1, 2 and 3 cover general information of primary interest to the users. Chapters 4 and 5 contain more technical, programmatic data of principle concern to FAA officials and technicans. Appendices A through D has additional information of interest to the aviation community as a whole.

The Microwave Landing System is a dynamic program. As implementation continues and valuable lessons are learned, some of the organizations and technical data presented herein will change. Also, some of the terminology which has been borrowed from the Instrument Landing System will evolve into more appropriate MLS terminology. For example, back course may become "back azimuth guidance", and glide path angle become "elevation angle", etc.

This document is intended to be used for informational purposes and should in no way be misinterpreted as an official directive.

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CHAPTER 1
INTRODUCTION AND OVERVIEW

PURPOSE

The purpose of this document is to provide those within the Federal Aviation Administration (FAA) and the aviation community with background information leading to a basic understanding of the Microwave Landing System (MLS) and its development. MLS is a dynamic program. The information and organizations involved will change as implementation continues. This document is intended to be used for informational purposes and should in no way be misinterpreted as an official directive.

Since MLS is a new system that is scheduled to replace the existing Instrument Landing System (ILS) worldwide during the remainder of this century, it is important that all aspects of the system be understood by everyone involved.

The information contained herein should provide the reader with an insight into the overall program activities. This document discusses the following subject areas: planning process, matrix management, transition from ILS to MLS as the worldwide precision landing system standard within 10 years, role of support organizations within FAA, role of the user groups, international requirements and coordination, program implementation, policy and procedures development, and role of the MLS Program Office.

BACKGROUND

The current generation ILS, which is an outgrowth of World War II technology, has served the aviation community for almost 40 years. During this time the FAA has continually upgraded ILS ground equipment to ensure high standards of reliability and improved safety. Major improvements to ILS were an improved antenna system and the changeover to solid state electronics which greatly enhanced the reliability and signal quality. ILS was not designed for, nor is it economically adaptable to, the improved performance characteristics of today's aircraft, high capacity requirements, noise abatement procedures, unique military operations, or the many other anticipated needs of the future.

From the time the first ILS system became operational until the planned beginning of its phase down in the mid-1980s, more than 750 ILSs will have been installed and placed in operational status (commissioned) in the U.S. During this period, ILS installations grew at an average rate of less than 20 systems per year. However, this growth was not uniform over the years; it was slow during the first 20 years and increased rapidly during the second 20 years. There was rapid growth in aviation in the U.S. during this latter period. It also was the beginning of the jet age. Today several hundred additional precision landing systems are needed. There are, however, some basic technological and design limitations with ILS which stimulated the search for a better system.

ILS Limitations

ILS has a number of basic limitations in terms of current and future aviation requirements:

- ILS provides only a single glide path which is not optimal for the high-angle approach capability of Short Takeoff and Landing (STOL) or Vertical Takeoff and Landing (VTOL) aircraft. It provides lateral guidance for only one approach azimuth precluding its use for segmented or curved approach paths, which require precise guidance at a wide range of azimuths.
- The glide slope is terrain dependent and expensive to install at difficult sites. Since it uses the ground in front of the glide slope antenna to form the signals in space, a large area in front of the site (antenna array) must be graded. The cost of this earthwork sometimes exceeds the cost of the ILS equipment.

● Signal reflections caused by rough terrain and mountainous regions limit ILS performance.

● Only 40 ILS channels are available. Therefore, frequency congestion threatens to become a serious problem in several parts of the country. It is already difficult to add new ILS facilities in congested areas such as the Los Angeles Basin.

● The ILS glide slope signal is sensitive to nearby reflections. This can reduce airport capacity at locations where departing aircraft must be held at a great distance from the takeoff threshold in order to avoid the critical reflection area when an instrument approach is in progress.

● In some regions ILS is subject to radio frequency interference from extraneous radio signals.

These are design limitations of the system itself. However, when ILS was implemented, it more than satisfied the needs of the numbers and types of aircraft operating in the U.S. National Airspace System. Today a more versatile system with greater capabilities than can be provided by ILS is required.

Search for An ILS Replacement

The search for a replacement for ILS has been ongoing for several years. Prior to 1970, over 50 different systems had been proposed and most of them employed microwave technology. Some of these systems were already in use by the military. The prospect of having many types of approach systems in use in different countries posed the threat that international operators would have to equip their aircraft with several different types of avionics. To preclude that possibility, the Radio Technical Commission for Aeronautics (RTCA) formed a Special Committee (SC-117) in 1967 to establish the technical requirements for a single system which could be endorsed by the International Civil Aviation Organization (ICAO) as a standard ILS replacement for worldwide implementation.

Concurrently, ICAO recognized the need and took action to establish an international standard. The U.S. work to develop a new landing system progressed in concert with the international program.

Prior to discussing MLS development, precision and non-precision approaches, flight rules, and approach categories will be discussed.

Approaches - The two types of approaches being practiced worldwide today are precision and non-precision depending on the weather and onboard avionics capabilities.

● A precision approach relies on an electronic signal for lateral approach course (Azimuth) and glide path (Elevation) guidance to the touchdown point on the runway. Distance (Range) information is also required. In the case of ILS, electronic markers and/or Distance Measuring Equipment (DME) are used for this purpose. With the Precision Approach Radar (PAR) used by the military, the range is determined by the controllers with reference to the radar scope. MLS, on the other hand, uses Precision DME only for range information and does not need markers. With ILS and MLS, the pilot controls both the flight path and descent by reference to instruments, whereas with PAR, instructions are furnished by the radar controller.

● A non-precision approach does not provide electronic glide path information, only Azimuth. Accordingly, the pilot controls the descent to a specific altitude after passing a predetermined position on the approach profile.

Flight Rules - There are two terms associated with inflight, approach and departure operations: Visual Flight Rules (VFR) and Instrument Flight Rules (IFR).

VFR - An aircraft conducting flight in an atmosphere where it can be seen by other aircraft and its pilot can see vertically and horizontally in accordance with existing VFR rules. In general, see and be seen.

IFR - An aircraft conducting flight in accordance with instrument flight rules. The weather conditions are below the minimum for flight under visual flight rules. In general, flying in clouds where the aircraft is controlled by reference to instruments and its progress is monitored by ATC.

Approach Categories - There are three landing

criteria categories for ILS and MLS precision approach procedures. The three categories are:

- Category I- An approach procedure which provides for approach to a height above touchdown of not less than 200 feet and with visibility of greater than one half mile or runway visual range (a computed visibility) of not less than 1,800 feet.
- Category II- An approach procedure which provides for approach to a height above touchdown of not less than 100 feet and with runway visual range of not less than 1,200 feet.
- Category III A, B and C

  IIIA - An approach procedure which provides for approach without a decision height minimum and with runway visual range of not less than 700 feet.

  IIIB - An approach procedure which provides for approach without a decision height minimum and with runway visual range of not less than 150 feet.

  IIIC - An approach procedure which provides for approach without a decision height minimum and without runway visual range at zero.

To support the three categories of approach procedures there are three distinct signal quality requirements of the MLS ground station: accuracy reliability, and integrity.

- Accuracy - MLS guidance in terms of azimuth and elevation angles and distance information is required to be within internationally agreed tolerance limits.
- Reliability - The probability that MLS guidance of specified accuracy is available to the aircraft.
- Integrity - The quality that relates to the trust that can be placed in the correctness of the guidance information.

National MLS Program

A National Microwave Landing System (NMLS) Program, was formulated jointly by the Department of Transportation (DOT)/Department of Defense (DOD)/National Aeronautics and Space Administration (NASA). Its goal was the development and acquisition of a common civil/military precision landing system which was incrementally capable of providing fully automatic approach and landing guidance down to Category III minima. It was determined that microwave equipment employing new technologies and techniques were the most responsive and cost-effective approach to providing many benefits not possible with ILS. Some of these benefits are:

- Availability of multiple approach paths with pilot-selectable azimuth and glide path angles.
- Relative ease and economy to install ground equipment, even at difficult terrain locations.
- Smaller components which permit tactical military ground versions.

The MLS design meets all the requirements for Category III (highest level) signal quality. In Category I and II operations, the pilot relies on the MLS ground system down to a predetermined height above touchdown at which point he breaks out of the clouds and makes visual contact with the runway, or initiates a missed approach procedure.

For Category III operations, the ground equipment has the capability to bring the aircraft to touchdown with nonvisual references. For Category III A and B, however, a Runway Visual Range (RVR) of not less than 700 feet and 150 feet respectively is required. For Category III C, no RVR is required.

Furthermore, each approach procedure category requires specific ground equipment configurations to support the specific category of operation. This can include such things as redundant equipment and multiple monitors, approach lights, clear zones, backup power, etc. There are also special aircraft and aircrew certifications required. One should be aware of these requirements, but the specifics of these requirements are not identified in this handbook.

MLS Development Plan

A National MLS Development Plan was finalized in July 1971, and the FAA was given the lead to manage the DOT/DOD/NASA joint program. The plan was updated in 1978. The program was designed to analyze, define, develop and evaluate microwave guidance techniques and associated landing system equipment for ground and airborne use which would be responsive to the future needs of civil and military airfields.

The current MLS design is based on the use of the Time Reference Scanning Beam (TRSB) technique, which was competitively selected over a Doppler technique by ICAO in April 1978 as the international landing system standard. ICAO published international Standards and Recommended Practices (SARPs) for the MLS angle (azimuth and elevation) and data subsystem in November 1982. ICAO, in its ninth meeting in December 1982, drafted SARPs for the MLS Precision Distance Measuring Equipment (DME-P) Range subsystem. DME-P is an integral part of MLS.

In the MLS avionics area, the Radio Technical Commission for Aeronautics (RTCA) Special Committee 139 (SC-139) published Minimum Operational Performance Standards (MOPS) for MLS airborne angle guidance equipment (RTCA-DO-177) in July 1981. Based on this document, FAA then issued Technical Standard Order (TSO) C-104 for avionics manufacturers to use when producing MLS angle guidance receiving equipment.

The initial development of the MLS is complete. The first production contract phase for fixed MLS ground equipment began in January 1984. The first FAA production model is scheduled to be installed and operational in late-1986. This will be the beginning of the transition from ILS to MLS. The first 10 years of MLS operation will be a transition period when both ILS and MLS will be used extensively. The FAA will purchase and commission very few ILSs during this period.

MLS Transition Plan

In the early 1980s, an MLS Transition Plan Working Group was established by FAA. The task of the group was to devise a plan to outline the optimum way to introduce the proposed MLS into the National Airspace System (NAS) as the replacement for the existing ILS. This effort produced the MLS Transition Plan, Report number APO-81-1, dated July 1981. This plan provides the basic guidance for developing the MLS implementation strategies and planning for the phase down of ILS.

MLS Key Decision Memorandum

A major step toward the realization of the MLS program occurred on April 8, 1983, when the Department of Transportation authorized the FAA to proceed with the acquisition of 1,250 MLSs by a Key Decision Memorandum (KDM). Immediately following this decision, the FAA released a Request For Proposals to industry for the first multi-year procurement for MLS ground equipment. The initial procurement was to provide for 172 systems utilizing funding over a five-year period, FY-82 through FY-86.

This in turn led to a production contract award on January 12, 1984, to Hazeltine Corporation. The contract provides for options which, if exercised, would bring the total MLS system procurement on the first contract to 208.

The MLS program calls for the establishment of 1,250 civil MLS sites by the year 2000. This will represent an average installation rate of approximately 85 systems per year. However, like ILS, the installation of MLS will start slowly, perhaps for the first two or three years, and then accelerate to the full program potential during the remainder of the program. It is possible that more than 1,250 MLSs will be required prior to the year 2000. The MLS program is structured so that it could accommodate additional requirements with budgetary and policy approvals.

MLS and the NAS Plan

The NAS Plan establishes an integrated program for improving, over a 20 year period, all FAA Facility and Equipment functions in support of aviation. The principal functions are air traffic control, surveillance, navigation, and communications. The theme for each of these functions is that improvements in safety, capacity, productivity, and economy will be realized through higher levels of automation and the application of modern, lower cost technologies. The MLS was specifically designed to fulfill these needs for the precision approach and landing navigation function, and it is considered an essential element of the NAS Plan in achieving the above goals.

MLS program planning has been and continues to be coordinated closely with NAS planning. Each follow on edition of the NAS Plan reflects MLS system definition and decisions made over the preceding year, and provides for a limited number of new ILSs to meet essential requirements. It also acknowledges that a substantial number of tube type ILS components will be upgraded with solid state equipment. MLS and NAS Plan coordination will continue throughout the life of the MLS program. MLS features required by the NAS Plan to support the growth of aviation well into the next century include:

- Availability of 200 channels
- Continuous angle and range indication
- Improved signal quality
- Reduced sensitivity to siting environment
- Wider guidance coverage sectors
- Basic system design and use of advanced technology

System to Date

Although much has been accomplished in the MLS program — planning and development work and the decision to acquire 1,250 systems — these accomplishments are only to the point where the first network of MLSs will be installed starting in 1986. The planning and development effort has set the stage for the FAA to proceed with the building blocks for the remainder of all the operational MLS systems scheduled for installation through the year 2000. FAA has placed a turnkey contract with Hazeltine Corporation aimed to ensure that MLS facilities will come on line quickly once production equipment starts to arrive in the field consistent with contract delivery schedules.

SHAPE OF THE NEXT 15 YEARS

The transition from ILS to MLS will occur during the next 15 years. During the first five years, effort will be focused on the development of criteria for the establishment of Terminal Instrument Procedures (TERPS). The development of specific procedures for individual MLS sites at given airports — both TERPS and ATC procedures — will continue throughout the life of the program.

Also to be considered is the user's perception of MLS. The Air Transport Aircraft equipped with MLS should occur as soon as it is operationally required and/or economically feasible. The commuter and regional airlines, on the other hand, will be among the first groups to benefit and will most likely equip their aircraft as soon as MLS is installed in areas where they operate. Finally, the instrument-equipped segment of the General Aviation (GA) fleet will monitor early installation activities and equip their aircraft when MLS is available at locations where they frequently fly, particularly at those locations that do not now have ILS, and when the price of avionics makes it affordable. The FAA plans to monitor this important phase of the program implementation to ensure that the users' needs are addressed. In addition, FAA will coordinate closely with users on MLS program implementation.

During the early years of MLS implementation, FAA regions will be the key players in ensuring that all site preparation work is fully coordinated and that early learning experiences are

well documented and incorporated in the national program. Their planning efforts in establishing MLS networks can be effectively correlated with users' requirements. Second, the regions will gain operational experience with each commissioning and will soon become an essential source of operational data. For example, maintenance personnel will be able to gather data and real time experience on the ground system hardware. Thus, the input from the regions will greatly assist the MLS Program Office in further refining its operational and maintenance policies and procedures during the early years of implementation.

The U.S. MLS program as planned and described in the transition plan is to be implemented in three phases.

Phase I of the U.S. MLS Implementation Plan

Approximately 30 MLS ground systems will be procured under the current production contract. The purpose of Phase I is to gain operational hands-on experience with those ground stations and achieve the following results:

- Gain engineering and technical data and refine siting criteria.
- Provide for evaluation of Flight Inspection procedures over a group of commissionable facilities.
- Affirm the delay reduction potential of MLS for aircraft that can utilize short runways, short approaches, and/or high descent angles.
- Allow operational evaluation of installed ground systems which are exposed to a variety of climatological conditions.
- Determine support requirements for fully operational MLS systems.
- Obtain users' views on utilization of the MLS.

Phase I Installations (Ground Equipment and Avionics)

Phase I spans approximately two years during which time MLS ground equipment will be installed at several hub airports. Particular attention will be focused on high density locations such as Boston Logan Airport and Washington National Airport. Operational experience will also be gained in the establishment of MLS networks as six networks will be developed during this time.

Some additional ILSs will be installed during this period, but at a decreasing rate. When new ILSs are installed, the amortization period for such equipment must be kept in mind. The ILS is protected at least until January 1, 1995, at all international airports.

Some ILS equipped aircraft will be retrofitted with MLS avionics when economic and operational benefits justify. New generation aircraft and newly developed models of existing aircraft will be fitted with ILS. These will also have provisions for MLS. This procedure will enable operational experience to be gained in an "in service" environment that will facilitate the development of MLS based procedures and permit further refinement of international SARPs.

Phase I Operations

MLS operations will mainly use "ILS-type" approaches, improved intercept procedures, and higher elevation angle approaches for VTOL and STOL operations. This phase will introduce segmented approaches in situations where the DME capability permits and where there is no conflict with ILS operations.

The operational knowledge and experience gained during Phase I should prove invaluable in assessing the need for any change or redirection when moving into Phase II. Since Phase I will serve as an operational shakedown for the remainder of the program, an effective Phase I will lead to follow on program efficiencies and economies.

Phase I Site Selection

Most of the direction and guidance in selecting the specific site location for this initial phas

/as done at the FAA national level for many alid reasons including:

1. Specific contractual requirements.
2. Limited equipment availability.
3. Establish typical hub and network airport scenarios.
4. Gain early operational experience.

However, some selections were made for reaons other than those which were operationally dvantageous. Such selections were made beause this phase is viewed as providing the veicle for setting standards for the remainder of rogram implementation. In that regard, the reions and users provided their inputs and, in nost cases, the operational needs and the techical needs vital to program implementation vere very complementary.

Phase II of the U.S. MLS Implementation Plan

Phase II is the heart of the implementation rogram and provides for approximately 900 round systems to be procured over a 10-year eriod. The MLS systems installed in this phase s well as Phase I will be required to meet stablishment criteria for MLS that support Category I, II, or III operations, i.e., baseline leployment consistent with the criteria in Airway Planning Standard Number One. When hase II is complete, there will be an MLS at very precision approach runway now known to ualify.

hase II Installation

Phase II, like Phase I, will be implemented n a hub-by-hub basis in priority order of large nd medium hub airports within the various regions. Network airports that support the hubs vill be given priority based on operational needs, vhich is referred to as "Hub and Spoke." In nany cases, these networks will cross regional oundaries requiring advanced coordination beween the regions. For the first few years of the rogram, network planning will be difficult due to the limited numbers of MLSs. The following years will only require an expansion and completion of the networks previously established.

In some cases during Phase II Implementation, there may be a need to install MLS equipment at stand alone locations. Stand alone locations are those not associated with a given network. An example may be an oil exploration airport which requires MLS but which is used almost exclusively by company aircraft involved in exploration work. Stand alone sites will be the exception even though provisions are included in MLS planning for the establishment of such facilities.

Special consideration will be given to the early establishment of a network in certain areas of the country. The Alaskan Region with its remote territory, rugged terrain and requirement for precision approach guidance into airports which are presently not equipped with ILS or other approach aids is an example of such an area. Since Alaska's total number of qualifying airports will be significantly less than in the other eight regions, its sites may be installed earlier than now planned.

Phase II Procurement

Although current planning calls for about 100 systems to be installed each year during Phase II, it may be advantageous to increase this number in the future. Such acceleration would offer two definite advantages:

- Minimize or reduce program costs.
- Accelerate the transition from ILS to MLS.

A procurement rate of more than 100 ground systems a year during Phase II would encourage MLS avionics equipage because of rapid development of the networks. A faster buildup of MLS ground systems could also reduce the burden on users who will otherwise have to carry both ILS and MLS equipment in their aircraft for a longer period. It should also reduce the funding impact associated with the operation and maintenance of dual systems.

A proposed MLS locations list has been developed for the first 172 sites. It includes location, airport and runway, runway length, antenna configuration, funding year and the network.

It is intended that ILS service will remain protected until the end of this period, January 1995. Existing ILS service will continue to be provided except at sites where it is no longer economical to do so. Providers of ILS service will need to consider very carefully whether it is worthwhile to install any new ILS equipment. It is very unlikely that there will be any further ILS installations during this phase.

As Phase II progresses, there will be increasing use of the MLS in accordance with regional air navigation planning where it can offer operational, technical or economic benefits. There will also continue to be a buildup of operational in-service experience of MLS. This will facilitate the certification of the MLS at the lowest possible minima for the specific sites.

Phase II Avionics Installation

Phase II will be a trend toward retrofitting existing aircraft with MLS in addition to ILS because of increased availability of MLS service. New aircraft of all types entering service during this period are likely to be delivered already fitted with MLS. Operational experience gained during Phase I and II should lead to the limited introduction of more complex approach procedures and low minima operations for MLS.

Phase III of the U.S. MLS Implementation Plan

Phase III will complete the MLS implementation as presently approved by the Key Decision Memorandum. The planned number of fa cilities to be installed during this phase is appro imately 300, at a rate of 100 each year. Th number of systems procured during this phas may be higher depending on requirements fc MLS in the 1995 time frame and beyond.

Phase III, Transition to MLS Completio

Phase III will represent the main transitio phase from ILS to MLS as MLS will be in broa use across the U.S. during this period. Users wi have the opportunity to procure MLS avionic equipment for their aircraft and more than 1 years to amortize existing ILS avionics and mov forward with plans for its removal. Conse quently, this adjustment should occur systen atically and not cause a significant economic im pact on the user.

During this period there will also be an ir creased use of MLS low minima operations an the introduction of more complex application c MLS procedures requiring segmented and curve patterns to be flown at certain airports. It is ex pected that procedural development work wi continue for further implementation and refine ment of complex applications to provide im proved safety, operational efficiencies, nois abatement and other environmental benefits

Beyond this phase, ILS will be withdrawn a an ICAO requirement. The MLS will then be th worldwide operational precision landing syste and all aircraft needing nonvisual precision ap proach and landing guidance will be equippe with MLS avionics.

DEPARTMENT OF DEFENSE MLS EFFORT

The U.S. Air Force (USAF) was designated the lead service for DOD MLS activities and tasked to submit an implementation plan to the Office of the Secretary of Defense (OSD) i coordination with the other services.

DOD MLS Implementation Plan

The DOD developed a Microwave Landing ystem Implementation Plan, dated August 1, 983. This plan considers the requirements of ll Military Services (Air Force, Army, Navy and larine Corps) and covers the time period rough the year 2000. Details of DOD's plan ere provided to the FAA for the purpose of lly coordinating DOD and FAA requirements. evelopment and acquisition efforts related to lavy/Marine Corps shipborne precision landing ystems are not a part of the DOD plan and, erefore, are not a part of the program support eing provided by FAA. The DOD plan is up-ated annually.

U.S. Air Force (Lead Service)

In addition to its in-house MLS program staff, he USAF has personnel assigned full time to AA to work with the MLS Program Manager nd the various organizations involved with MLS ithin FAA. Also, military counterparts are in-ited to all major program activities, and copies f important documentation are provided to hem.

At fixed bases in the Continental U.S. CONUS), Air Force MLS equipment shall be dentical to that being procured by the FAA for ivil installation, effective with FAA's second LS contract and specifications (presently in the lanning stage). Further, all fixed base DOD CONUS MLS equipment shall be acquired hrough the FAA. The USAF has maintained aison with FAA since mid-1983 to assure that he FAA's second MLS acquisition contract eets all DOD needs for CONUS fixed base in-tallations. The Air Force plans to acquire 191 LSs during the second and third contracts.

The development, test, and acquisition of a nodular tactical/transportable MLS ground ystem for the Air Force is authorized by the OD plan. These systems, however, will not be rocured by the FAA and are not a part of AA's MLS Program.

Commercial MLS airborne receivers may be acquired to meet near term USAF and Army requirements for transport type aircraft. Specific OSD approval is required prior to initiation of any new military avionics development program. Duplication of effort or proliferation of avionics equipment types must be avoided.

The USAF has the responsibility for the overall coordination with the other military services for their MLS requirements which must be jointly planned with FAA for the acquisition of the MLS ground systems. There is also a close and required relationship on the FAA/DOD MLS programs relating to the avionics system hardware to ensure interoperability with the tactical and fixed base systems.

U.S. Army

The Army will have the smallest requirement for MLS systems being procured under the FAA contracts. The Army will receive two systems from the first contract and 26 additional systems on the second contract. The Army's requirement, to a large degree, centers around helicopter operations. Table 1-1 illustrates DOD's MLS acquisition schedule.

U.S. Navy/Marine Corps

The Navy/Marine Corps, like the Air Force, will have a significant requirement for fixed base MLS ground equipment. Presently, that requirement is for 107 systems which will be acquired during FAA's second and third contract phases. Eighty systems will be purchased on FAA's second contract and 27 on the third contract. The year-to-year procurement planning schedule is illustrated in Table 1-1.

The Navy/Marine Corps will equip its aircraft with multi-mode receivers during the 1988-1998 time frame. Its aircraft will be interoperable with the civil sector, the Air Force, and the Army regardless of the state of ILS/MLS transition.

TABLE 1-1
DOD's MLS ACQUISITION SCHEDULE

	FY*	FAA	DOD TOTAL	USA	USN/USMC	USAF
Contract 1	82-86	206	2	2	—	—
Contract 2	86	—	10	—	10	—
	87	100	28	11	14	3
	88	100	35	15	14	6
	89	100	22	—	14	8
	90	100	39	—	14	25
	91	100	39	—	14	25
Contract 3	92	100	39	—	14	25
	93	100	38	—	13	25
	94	100	25	—	—	25
	95	100	25	—	—	25
	96	144	24	—	—	24
TOTALS		1,250	326	28	107	191

*Funding Year

MLS REQUIRED RESOURCES

Considerable resources will be required to implement the national MLS program: personnel, materiel, and financial. Table 1-2 contains summary listings of the resources.

TABLE 1-2
MLS REQUIRED RESOURCES

PERSONNEL	MATERIEL	FINANCIAL
Facility technicians (maintenance)	EI Station	
Air Traffic Controllers	AZ Station/DME-P	F&E Ground System Requirements
Regional Engineers	Remote Maintenance Monitoring Systems	R&D Funds
Flight Inspection Personnel	Primary AC Power Source	NASA Joint Programs
Pilots	Secondary DC Battery Package	FAA/USAF Wide Body Test
Panel Technicians	On-site Maintenance Spare Parts	Rotorcraft Demonstration
ATC Procedures Specialists	Depot Spare Parts	TERPs/FI Procedures Development
TERPs Procedures Specialists	Repair Facility	ATC Procedures Development
Planning Specialists	Communications Link	Facility Flight Inspection
Matrix Management Team	User Avionics	Maintenance Operations
FAA Plant Representatives	Ground Vehicles	MLS Training
Contracting Specialists	Flight Inspection Capability	Spare Parts
Contractor Personnel	(aircraft/avionics)	ACT Support
FAA Top Management		Region's MLS Installation Programs
Budget Specialists		Factory Inspection/Quality Assuran
Training Specialists		
Contract Officer Technical Representatives		
Qualified User Aircrews		

INTRODUCTION AND OVERVIEW SUMMARY

A review of the overall MLS Program shows hat all past, present and planned ac-omplishments support national management ›bjectives. The major MLS organizations of the J.S. government (DOD, DOT/FAA, NASA) ıave worked together to define and develop a ommon precision landing system to replace the xisting ILS system. These efforts supported the ıternational community through ICAO to de-elop a worldwide ICAO approved system. In \pril 1978, ICAO selected the Time Reference ¦canning Beam (TRSB) MLS as the new inter-ıational landing system standard. This standard omplemented the ongoing planning effort in the J.S. for FAA's present MLS system which is ıow in the implementation process.

The FAA moved quickly with its transition lan once the international standard was es-ıblished and a common system defined. The ·ansition plan was an important step towards nplementation as it established the methods and oncepts of how the FAA would move from the LS standard to the MLS standard in a period f about 15 years.

DOT, through the issuance of a Key Decision Memorandum on April 8, 1983, authorized FAA ɔ proceed with the acquisition of 1,250 MLS round systems over a 15-year period. Im-ıediately thereafter, FAA initiated procurement ction for the first 208 MLS ground systems by warding a contract to the Hazeltine Corpora-.on in January 1984. A three-phased implemen-ıation plan will be completed during the next 15 ears.

The three phases of the MLS program are in-ɜnded to accomplish various things as describ-d below:

- Phase I — Phase I will gain operational ands-on experience from the first group of round stations that are procured by FAA in its ıitial production contract. The first 30 systems /ill be installed within three years. This phase /ill be instrumental in the development of TERPs, Flight Inspection and Air Traffic Control procedures.

- Phase II — Phase II will cover a period of 10 years and will provide for the installation of approximately 900 MLS ground stations. This phase is the heart of the program and will accomplish much of the development of the Hub/Network airport concepts. It is a time when MLS will come into widespread use by the users. Procedures development will be essentially completed. Trends will have begun for the phaseout of ILS and its widespread replacement by MLS. The transition of airborne avionics from ILS to MLS will be in a dual use mode and will move towards a changeover to MLS. Much of the required MLS equipage of the aircraft by the users will be well underway.

- Phase III — Phase III is scheduled for a three-year duration and will complete the installation of an additional 300 MLS ground systems which will finalize the planned acquisition of the 1,250 systems under the program. MLS will be in broad use across the U.S. This period will be the main transition from ILS to MLS. Users will have had time to equip their aircraft and will have had sufficient operational experience to make the changeover to full utilization of MLS. It will be a time to complete the definition on any remaining ground system requirement and to arrange for the procurement of necessary hardware. Phase III will be completed prior to the beginning of the 21st century.

The need and desirability of a single U.S. precision landing system compatible with the ICAO international standard has been emphasized. To this end, DOD, DOT/FAA, and NASA have worked together for the development of MLS, under the auspices of a national program. FAA was assigned the lead role to manage the program. DOD has agreed that FAA will satisfy all of its requirements for MLS fixed base stations in the CONUS through FAA procurement contracts. DOD has charged the Air Force as the lead military service to ensure that all DOD requirements, including avionics,

ground stations, procedures and operational requirements, are addressed in this program. As the lead service, the USAF will accomplish the necessary coordination and liaison with the Army, Navy and Marine Corps. The overa planned requirement for the MLS ground sy: tems being procured by FAA for DOD durin the implementation period is 326 systems.

Chapter 2

WHY MLS

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CHAPTER 2
WHY MLS

INTRODUCTION

Why should MLS be implemented as opposed to further development and refinement of ILS? Essentially, ILS does not adequately meet the wide range of user and operational requirements facing aviation today nor does it satisfy the increased demands of the future. MLS, on the other hand, has all of the essential features necessary to support aviation growth well into the next century.

ILS has been a good system that has served the Aviation Community long and well. However, the requirements of the 1980s and beyond simply require operational features that are beyond the capability of ILS.

MLS, PART OF THE NATIONAL AIRSPACE SYSTEM (NAS)

The MLS implementation has been planned for and is a part of the FAA NAS Plan. As a part of that planning process, MLS and ILS will coexist in the National Airspace System for several years before the phaseout of ILS is started. By international agreement, FAA is committed to retain ILS at international airports until at least 1995.

Initial MLS Sitings

FAA plans MLS installations at both runways not now equipped with ILS and at locations with ILS. MLS installations will be grouped to serve primary users in a given area which is referred to as "Hub and Spoke". This does not preclude installations outside these areas, and there is considerable user interest in early installation at many locations with difficult geography.

Number of MLS Installations

The number of MLS installations will far exceed the number of existing ILSs because of MLSs additional operational capabilities. For example, there are currently about 750 civil ILS installations in the U.S. FAA estimates that the system could accommodate about 1,400 ILS installations before saturation, depending on geographical location. MLS installations under the current Federal Program are projected at 1,250 systems. In addition, there will be some 326 military MLSs replacing military ILS and PARS, and several hundred nonfederal systems.

MLS ADVANTAGES

MLS offers significant benefits to the users and FAA through its ability to overcome the limitations of ILS and by providing additional applications that are derived from modern technology. It has all of the essential features necessary to support the growth of aviation well into the next century. MLS is a part of and will be incorporated into the NAS over the next 15 years.

Signal Accuracy

MLS has improved signal accuracy over ILS. During flight testing MLS has been demonstrated as consistently satisfying the high accuracy standards set for Category III operations.

Some of the reasons for this improved accuracy are listed below:

- Use of Time Reference Scanning Beam

techniques.

- Use of Digital Design Technology.
- Signal is not dependent on ground plane in front of the antenna.
- Microwave frequencies are not as adversely affected by terrain as are VHF frequencies. The frequencies allow for designing antennas with controlled patterns.
- Antennas are smaller and monitoring is less sensitive to weather effects.

Flexibility

Compared to ILS, MLS offers greater approach path operational flexibility. For example, MLS provides multiple approach azimuth and glidepath guidance simultaneously to a variety of users. The capability exists for curved and segmented approaches. Large commercial jets, smaller aircraft, short takeoff and landing aircraft, and helicopters can all conduct approaches designed for their specific capabilities.

Reliability

Improvements in ILS system reliability is tied to the VHF/UHF operating frequency range because ILS antennas are large and require that land be leveled and extensively conditioned. This conditioning includes providing a large "ground plane" area in front of the glide slope antenna to form the beam in space. MLS, which utilizes microwave frequencies, has much smaller antennas and is much less susceptible to weather and climatic conditions which affect the ILS antenna and ground plane. Furthermore, MLS uses Microwave Digital Design Technology to provide reliable data transmission. For example, runway conditions, etc.

Size

The small modular configuration of the MLS equipment will reduce the spares inventory requirement and will provide for ease of maintenance. The Remote Maintenance Monitoring System provided for with MLS will require fewer maintenance personnel and provide for greater failure prediction. This will significantly lower maintenance costs.

Adaptable Geographically

At most locations, the full ± 40° scan coverage will be usable. At sites with difficult terrain, the coverage can be reduced to as little as ± 10°. In addition, the scan coverage can be adjusted to one side or the other to accommodate special requirements. The existing geography of any airport, large or small requires little or no modification for the installation and operation of MLS. Therefore, no extensive grading or additional land purchases are required as with ILS at difficult sites.

Economical

The installation cost of MLS is expected to be less than that of ILS. In addition, the operational cost will be greatly reduced because of higher reliability and the Remote Maintenance Monitoring System (RMMS) capability. ILS is currently being retrofitted with RMMS. Some of the items that lead to the higher ILS costs are:

- Unknown factors in siting.
- Preparation of ground plane areas.
- Construction requirements.
- Flight Inspection time.
- Maintenance operations.

CURRENT LANDING SYSTEM LIMITATIONS

ILS has served as the standard precision approach and landing aid for the past 40 years. During this time, it has served well and has undergone a number of improvements to increase its performance and reliability. However, in relation to future aviation requirements, ILS has a number of basic limitations.

Site Criticality

ILS is site-critical and expensive to install. Because it uses the ground in front of the glide slope antenna to form the beam, a large area in front of this antenna must be leveled. Conse-

quently, the site preparation cost sometimes exceeds the total cost of the equipment.

Glide Slope Sensitivity

The glide slope is sensitive to nearby reflections. This can reduce airport capacity at locations where departing aircraft must be held at a great distance from the takeoff threshold to avoid the critical reflection area when an instrument approach is in progress.

Limited Frequencies

Only 40 ILS channels are available and frequency congestion is becoming a serious problem in several parts of the country. It is already difficult to add ILS facilities in congested areas such as the Los Angeles Basin.

Lack of Flexibility

ILS lacks the flexibility needed for future aircraft operations. It provides only a single glide path and it is not adaptable to high-angle approaches by STOL aircraft or rotorcraft. It provides azimuth guidance to a single approach path over a very narrow sector (See Figure 2-1). This precludes its use for segmented or curved approach paths.

Terrain Limited

Signal reflections limit ILS applications in rough terrain and in mountainous regions.

MLS GROUND SYSTEM AND EQUIPMENT

The MLS ground system is comprised of several pieces of equipment. How each operates and functions as a part of the system is discussed below.

Ground Equipment and Layout

The MLS ground system includes the following major elements:

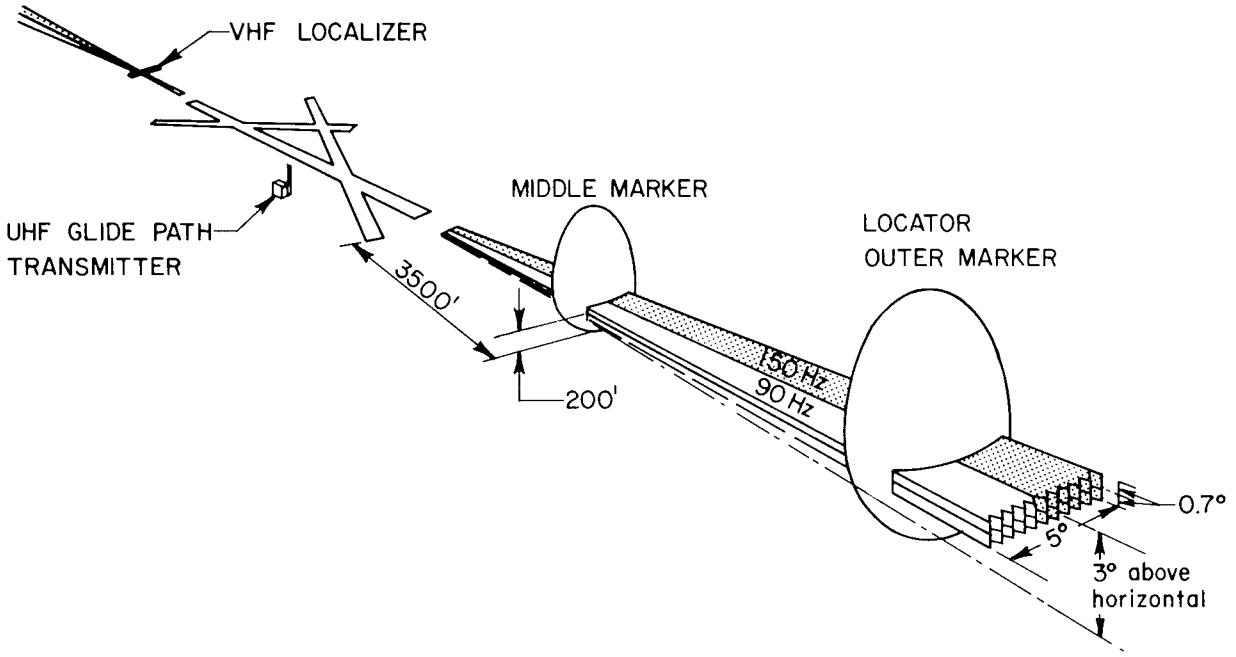


Figure 2-1: ILS Coverage

- Azimuth (AZ)
- Elevation (EL)
- Precision Distance Measuring Equipment (DME/P)
- Back Azimuth (BAZ)
- Data

A typical layout of MLS ground station elements is depicted in Figure 2-2. The BAZ is optional. Only about 20 percent of the MLS installations in the initial FAA procurement will have Back Azimuth.

Azimuth

The approach Azimuth (AZ) station provides lateral navigation guidance. It transmits basic data communications, information associated directly with the operation of the landing system, as well as advisory data on the performance level of the ground equipment. The Azimuth station transmits on one of the 200 MLS channels within the C-band frequency range of 5031 to 5090.7 MHz (see Table 2-1). The azimuth coverage of the system extends as follows:

- Laterally, at least 40° on either side of th runway. (Some systems will be 60°.)
- In elevation, up to an angle of 15°, and t at least 20,000 feet.
- In range, to a distance of at least 2(nautical miles (NM).

The Azimuth Station (AZ) is analogous to a ILS localizer but has a much wider proportion guidance coverage, as shown in Figure 2-3A Consequently, a single AZ can provide approac guidance to additional runways or helipads o the airport.

Elevation

The approach elevation (EL) station provide precision elevation guidance on the same carrie frequency as the azimuth station. This single fre quency is time-shared between all angle and dat functions. Elevation coverage is provided in th approach region throughout the same volume o airspace as the azimuth guidance signals namely:

- In elevation, to at least + 15°.

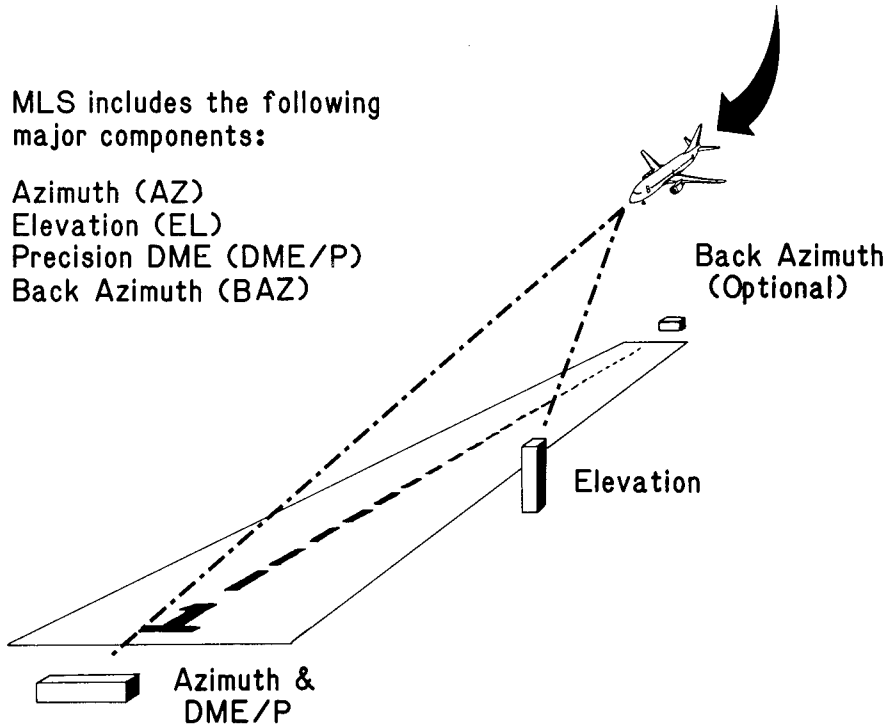


Figure 2-2: General Layout of MLS Ground Stations

TABLE 2-1: MLS CHANNELING AND PAIRING

CHANNEL PAIRING				DME PARAMETERS					
				INTERROGATION				REPLY	
					PULSE CODES				
						DME/P MODE			
DME	VHF FREQ.	MLS ANGLE FREQ.	MLS CH	FREQ.	DME/N	IA	FA	FREQ.	PULSE CODES
NO	MHz	MHz	NO	MHz	us	us	us	MHz	us
* 1X	-	-	-	1025	12	-	-	962	12
** 1Y	-	-	-	1025	36	-	-	1088	30
* 2X	-	-	-	1026	12	-	-	963	12
** 2Y	-	-	-	1026	36	-	-	1089	30
* 3X	-	-	-	1027	12	-	-	964	12
** 3Y	-	-	-	1027	36	-	-	1090	30
* 4X	-	-	-	1028	12	-	-	965	12
** 4Y	-	-	-	1028	36	-	-	1091	30
* 5X	-	-	-	1029	12	-	-	966	12
** 5Y	-	-	-	1029	36	-	-	1092	30
* 6X	-	-	-	1030	12	-	-	967	12
** 6Y	-	-	-	1030	36	-	-	1093	30
* 7X	-	-	-	1031	12	-	-	968	12
** 7Y	-	-	-	1031	36	-	-	1094	30
* 8X	-	-	-	1032	12	-	-	969	12
** 8Y	-	-	-	1032	36	-	-	1095	30
* 9X	-	-	-	1033	12	-	-	970	12
** 9Y	-	-	-	1033	36	-	-	1096	30
*10X	-	-	-	1034	12	-	-	971	12
**10Y	-	-	-	1034	36	-	-	1097	30
*11X	-	-	-	1035	12	-	-	972	12
**11Y	-	-	-	1035	36	-	-	1098	30
*12X	-	-	-	1036	12	-	-	973	12
**12Y	-	-	-	1036	36	-	-	1099	30
*13X	-	-	-	1037	12	-	-	974	12
**13Y	-	-	-	1037	36	-	-	1100	30
*14X	-	-	-	1038	12	-	-	975	12
**14Y	-	-	-	1038	36	-	-	1101	30
*15X	-	-	-	1039	12	-	-	976	12
**15Y	-	-	-	1039	36	-	-	1102	30
*16X	-	-	-	1040	12	-	-	977	12
**16Y	-	-	-	1040	36	-	-	1103	30
▽17X	108.00	-	-	1041	12	-	-	978	12
17Y	108.05	5043.0	540	1041	36	36	42	1104	30
17Z	-	5043.3	541	1041	-	21	27	1104	15
18X	108.10	5031.0	500	1042	12	12	18	979	12
18W	-	5031.3	501	1042	-	24	30	979	24
18Y	108.15	5043.6	542	1042	36	36	42	1105	30
18Z	-	5043.9	543	1042	-	21	27	1105	15
19X	108.20	-	-	1043	12	-	-	980	12
19Y	108.25	5044.2	544	1043	36	36	42	1106	30
19Z	-	5044.5	545	1043	-	21	27	1106	15
20X	108.30	5031.6	502	1044	12	12	18	981	12
20W	-	5031.9	503	1044	-	24	30	981	24
20Y	108.35	5044.8	546	1044	36	36	42	1107	30
20Z	-	5045.1	547	1044	-	21	27	1107	15

TABLE 2-1 (CONTINUED)

CHANNEL PAIRING				DME PARAMETERS					
				INTERROGATION				REPLY	
					PULSE CODES				
						DME/P MODE			
DME	VHF FREQ.	MLS ANGLE FREQ.	MLS CH	FREQ.	DME/N	IA	FA	FREQ.	PULSE CODES
No	MHz	MHz	No	MHz	us	us	us	MHz	us
21X	108.40	-	-	1045	12	-	-	982	12
21Y	108.45	5045.4	548	1045	36	36	42	1108	30
21Z	-	5045.7	549	1045	-	21	27	1108	15
22X	108.50	5032.2	504	1046	12	12	18	983	12
22W	-	5032.5	505	1046	-	24	30	983	24
22Y	108.55	5046.0	550	1046	36	36	42	1109	30
22Z	-	5046.3	551	1046	-	21	27	1109	15
23X	108.60	-	-	1047	12	-	-	984	12
23Y	108.65	5046.6	552	1047	36	36	42	1110	30
23Z	-	5046.9	553	1047	-	21	27	1110	15
24X	108.70	5032.8	506	1048	12	12	18	985	12
24W	-	5033.1	507	1048	-	24	30	985	24
24Y	108.75	5047.2	554	1048	36	36	42	1111	30
24Z	-	5047.5	555	1048	-	21	27	1111	15
25X	108.80	-	-	1049	12	-	-	986	12
25Y	108.85	5047.8	556	1049	36	36	42	1112	30
25Z	-	5048.1	557	1049	-	21	27	1112	15
26X	108.90	5033.4	508	1050	12	12	18	987	12
26W	-	5033.7	509	1050	-	24	30	987	24
26Y	108.95	5048.4	558	1050	36	36	42	1113	30
26Z	-	5048.7	559	1050	-	21	27	1113	15
27X	109.00	-	-	1051	12	-	-	988	12
27Y	109.05	5049.0	560	1051	36	36	42	1114	30
27Z	-	5049.3	561	1051	-	21	27	1114	15
28X	109.10	5034.0	510	1052	12	12	18	989	12
28W	-	5034.3	511	1052	-	24	30	989	24
28Y	109.15	5049.6	562	1052	36	36	42	1115	30
28Z	-	5049.9	563	1052	-	21	27	1115	15
29X	109.20	-	-	1053	12	-	-	990	12
29Y	109.25	5050.2	564	1053	36	36	42	1116	30
29Z	-	5050.5	565	1053	-	21	27	1116	15
30X	109.30	5034.6	512	1054	12	12	18	991	12
30W	-	5034.9	513	1054	-	24	30	991	24
30Y	109.35	5050.8	566	1054	36	36	42	1117	30
30Z	-	5051.1	567	1054	-	21	27	1117	15
31X	109.40	-	-	1055	12	-	-	992	12
31Y	109.45	5051.4	568	1055	36	36	42	1118	30
31Z	-	5051.7	569	1055	-	21	27	1118	15
32X	109.50	5035.2	514	1056	12	12	18	993	12
32W	-	5035.5	515	1056	-	24	30	993	24
32Y	109.55	5052.0	570	1056	36	36	42	1119	30
32Z	-	5052.3	571	1056	-	21	27	1119	15
33X	109.60	-	-	1057	12	-	-	994	12
33Y	109.65	5052.6	572	1057	36	36	42	1120	30
33Z	-	5052.9	573	1057	-	21	27	1120	15
34X	109.70	5035.8	516	1058	12	12	18	995	12
34W	-	5036.1	517	1058	-	24	30	995	24
34Y	109.75	5053.2	574	1058	36	36	42	1121	30

TABLE 2-1 (CONTINUED)

CHANNEL PAIRING				DME PARAMETERS					
				INTERROGATION				REPLY	
					PULSE CODES				
						DME/P MODE			
DME	VHF FREQ.	MLS ANGLE FREQ.	MLS CH	FREQ.	DME/N	IA	FA	FREQ.	PULSE CODES
No	MHz	MHz	No	MHz	us	us	us	MHz	us
34Z	-	5053.5	575	1058	-	21	27	1121	15
35X	109.80	-	-	1059	12	-	-	996	12
35Y	109.85	5053.8	576	1059	36	36	42	1122	30
35Z	-	5054.1	577	1059	-	21	27	1122	15
36X	109.90	5036.4	518	1060	12	12	18	997	12
36W	-	5036.7	519	1060	-	24	30	997	24
36Y	109.95	5054.4	578	1060	36	36	42	1123	30
36Z	-	5054.7	579	1060	-	21	27	1123	15
37X	110.00	-	-	1061	12	-	-	998	12
37Y	110.05	5055.0	580	1061	36	36	42	1124	30
37Z	-	5055.3	581	1061	-	21	27	1124	15
38X	110.10	5037.0	520	1062	12	12	18	999	12
38W	-	5037.3	521	1062	-	24	30	999	24
38Y	110.15	5055.6	582	1062	36	36	42	1125	30
38Z	-	5055.9	583	1062	-	21	27	1125	15
39X	110.20	-	-	1063	12	-	-	1000	12
39Y	110.25	5056.2	584	1063	36	36	42	1126	30
39Z	-	5056.5	585	1063	-	21	27	1126	15
40X	110.30	5037.6	522	1064	12	12	18	1001	12
40W	-	5037.9	523	1064	-	24	30	1001	24
40Y	110.35	5056.8	586	1064	36	36	42	1127	30
40Z	-	5057.1	587	1064	-	21	27	1127	15
41X	110.40	-	-	1065	12	-	-	1002	12
41Y	110.45	5057.4	588	1065	36	36	42	1128	30
41Z	-	5057.7	589	1065	-	21	27	1128	15
42X	110.50	5038.2	524	1066	12	12	18	1003	12
42W	-	5038.5	525	1066	-	24	30	1003	24
42Y	110.55	5058.0	590	1066	36	36	42	1129	30
42Z	-	5058.3	591	1066	-	21	27	1129	15
43X	110.60	-	-	1067	12	-	-	1004	12
43Y	110.65	5058.6	592	1067	36	36	42	1130	30
43Z	-	5058.9	593	1067	-	21	27	1130	15
44X	110.70	5038.8	526	1068	12	12	18	1005	12
44W	-	5039.1	527	1068	-	24	30	1005	24
44Y	110.75	5059.2	594	1068	36	36	42	1131	30
44Z	-	5059.5	595	1068	-	21	27	1131	15
45X	110.80	-	-	1069	12	-	-	1006	12
45Y	110.85	5059.8	596	1069	36	36	42	1132	30
45Z	-	5060.1	597	1069	-	21	27	1132	15
46X	110.90	5039.4	528	1070	12	12	18	1007	12
46W	-	5039.7	529	1070	-	24	30	1007	24
46Y	110.95	5060.4	598	1070	36	36	42	1133	30
46Z	-	5060.7	599	1070	-	21	27	1133	15
47X	111.00	-	-	1071	12	-	-	1008	12
47Y	111.05	5061.0	600	1071	36	36	42	1134	30
47Z	-	5061.3	601	1071	-	21	27	1134	15
48X	111.10	5040.0	530	1072	12	12	18	1009	12
48W	-	5040.3	531	1072	-	24	30	1009	24

TABLE 2-1 (CONTINUED)

CHANNEL PAIRING				DME PARAMETERS.					
				INTERROGATION				REPLY	
					PULSE CODES				
				F	D	DME/P MODE		F	
DME	VHF FREQ.	MLS ANGLE FREQ.	MLS CH	R E Q.	M E/ N	1A	FA	R E Q.	PULSE CODES
No	MHz	MHz	No	MHz	us	us	us	MHz	us
48Y	111.15	5061.6	602	1072	36	36	42	1135	30
48Z	-	5061.9	603	1072	-	21	27	1135	15
49X	111.20	-	-	1073	12	-	-	1010	12
49Y	111.25	5062.2	604	1073	36	36	42	1136	30
49Z	-	5062.5	605	1073	-	21	27	1136	15
50X	111.30	5040.6	532	1074	12	12	18	1011	12
50W	-	5040.9	533	1074	-	24	30	1011	24
50Y	111.35	5062.8	606	1074	36	36	42	1137	30
50Z	-	5063.1	607	1074	-	21	27	1137	15
51X	111.40	-	-	1075	12	-	-	1012	12
51Y	111.45	5063.4	608	1075	36	36	42	1138	30
51Z	-	5063.7	609	1075	-	21	27	1138	15
52X	111.50	5041.2	534	1076	12	12	18	1013	12
52W	-	5041.5	535	1076	-	24	30	1013	24
52Y	111.55	5064.0	610	1076	36	36	42	1139	30
52Z	-	5064.3	611	1076	-	21	27	1139	15
53X	111.60	-	-	1077	12	-	-	1014	12
53Y	111.65	5064.6	612	1077	36	36	42	1140	30
53Z	-	5064.9	613	1077	-	21	27	1140	15
54X	111.70	5041.8	536	1078	12	12	18	1015	12
54W	-	5042.1	537	1078	-	24	30	1015	24
54Y	111.75	5065.2	614	1078	36	36	42	1141	30
54Z	-	5065.5	615	1078	-	21	27	1141	15
55X	111.80	-	-	1079	12	-	-	1016	12
55Y	111.85	5065.8	616	1079	36	36	42	1142	30
55Z	-	5066.1	617	1079	-	21	27	1142	15
56X	111.90	5042.4	538	1080	12	12	18	1017	12
56W	-	5042.7	539	1080	-	24	30	1017	24
56Y	111.95	5066.4	618	1080	36	36	42	1143	30
56Z	-	5066.7	619	1080	-	21	27	1143	15
57X	112.00	-	-	1081	12	-	-	1018	12
57Y	112.05	-	-	1081	36	-	-	1144	30
58X	112.10	-	-	1082	12	-	-	1019	12
58Y	112.15	-	-	1082	36	-	-	1145	30
59X	112.20	-	-	1083	12	-	-	1020	12
59Y	112.25	-	-	1083	36	-	-	1146	30
**60X	-	-	-	1084	12	-	-	1021	12
**60Y	-	-	-	1084	36	-	-	1147	30
**61X	-	-	-	1085	12	-	-	1022	12
**61Y	-	-	-	1085	36	-	-	1148	30
**62X	-	-	-	1086	12	-	-	1023	12
**62Y	-	-	-	1086	36	-	-	1149	30
**63X	-	-	-	1087	12	-	-	1024	12
**63Y	-	-	-	1087	36	-	-	1150	30
**64X	-	-	-	1088	12	-	-	1151	12
**64Y	-	-	-	1088	36	-	-	1025	30
**65X	-	-	-	1089	12	-	-	1152	12
**65Y	-	-	-	1089	36	-	-	1026	30

TABLE 2-1 (CONTINUED)

CHANNEL PAIRING				DME PARAMETERS					
				INTERROGATION				REPLY	
					PULSE CODES				
						DME/P MODE			
DME	VHF FREQ.	MLS ANGLE FREQ.	MLS CH	FREQ.	DME/N	1A	FA	FREQ.	PULSE CODES
No	MHz	MHz	No	MHz	us	us	us	MHz	us
**66X	-	-	-	1090	12	-	-	1153	12
**66Y	-	-	-	1090	36	-	-	1027	30
**67X	-	-	-	1091	12	-	-	1154	12
**67Y	-	-	-	1091	36	-	-	1028	30
**68X	-	-	-	1092	12	-	-	1155	12
**68Y	-	-	-	1092	36	-	-	1029	30
**69X	-	-	-	1093	12	-	-	1156	12
**69Y	-	-	-	1093	36	-	-	1030	30
70X	112.30	-	-	1094	12	-	-	1157	12
**70Y	112.35	-	-	1094	36	-	-	1031	30
71X	112.40	-	-	1095	12	-	-	1158	12
**71Y	112.45	-	-	1095	36	-	-	1032	30
72X	112.50	-	-	1096	12	-	-	1159	12
**72Y	112.55	-	-	1096	36	-	-	1033	30
73X	112.60	-	-	1097	12	-	-	1160	12
**73Y	112.65	-	-	1097	36	-	-	1034	30
74X	112.70	-	-	1098	12	-	-	1161	12
**74Y	112.75	-	-	1098	36	-	-	1035	30
75X	112.80	-	-	1099	12	-	-	1162	12
**75Y	112.85	-	-	1099	36	-	-	1036	30
76X	112.90	-	-	1100	12	-	-	1163	12
**76Y	112.95	-	-	1100	36	-	-	1037	30
77X	113.00	-	-	1101	12	-	-	1164	12
**77Y	113.05	-	-	1101	36	-	-	1038	30
78X	113.10	-	-	1102	12	-	-	1165	12
**78Y	113.15	-	-	1102	36	-	-	1039	30
79X	113.20	-	-	1103	12	-	-	1166	12
**79Y	113.25	-	-	1103	36	-	-	1040	30
80X	113.30	-	-	1104	12	-	-	1167	12
80Y	113.35	5067.0	620	1104	36	36	42	1041	30
80Z	-	5067.3	621	1104	-	21	27	1041	15
81X	113.40	-	-	1105	12	-	-	1168	12
81Y	113.45	5067.6	622	1105	36	36	42	1042	30
81Z	-	5067.9	623	1105	-	21	27	1042	15
82X	113.50	-	-	1106	12	-	-	1169	12
82Y	113.55	5068.2	624	1106	36	36	42	1043	30
82Z	-	5068.5	625	1106	-	21	27	1043	15
83X	113.60	-	-	1107	12	-	-	1170	12
83Y	113.65	5068.8	626	1107	36	36	42	1044	30
83Z	-	5069.1	627	1107	-	21	27	1044	15
84X	113.70	-	-	1108	12	-	-	1171	12
84Y	113.75	5069.4	628	1108	36	36	42	1045	30
84Z	-	5069.7	629	1108	-	21	27	1045	15
85X	113.80	-	-	1109	12	-	-	1172	12
85Y	113.85	5070.0	630	1109	36	36	42	1046	30
85Z	-	5070.3	631	1109	-	21	27	1046	15
86X	113.90	-	-	1110	12	-	-	1173	12
86Y	113.95	5070.6	632	1110	36	36	42	1047	30

TABLE 2-1 (CONTINUED)

CHANNEL PAIRING				DME PARAMETERS					
				INTERROGATION				REPLY	
					PULSE CODES				
						DME/P MODE			
DME	VHF FREQ.	MLS ANGLE FREQ.	MLS CH	FREQ.	DME/N	IA	FA	FREQ.	PULSE CODES
No	MHz	MHz	No	MHz	us	us	us	MHz	us
86Z	-	5070.9	633	1110	-	21	27	1047	15
87X	114.00	-	-	1111	12	-	-	1174	12
87Y	114.05	5071.2	634	1111	36	36	42	1048	30
87Z	-	5071.5	635	1111	-	21	27	1048	15
88X	114.10	-	-	1112	12	-	-	1175	12
88Y	114.15	5071.8	636	1112	36	36	42	1049	30
88Z	-	5072.1	637	1112	-	21	27	1049	15
89X	114.20	-	-	1113	12	-	-	1176	12
89Y	114.25	5072.4	638	1113	36	36	42	1050	30
89Z	-	5072.7	639	1113	-	21	27	1050	15
90X	114.30	-	-	1114	12	-	-	1177	12
90Y	114.35	5073.0	640	1114	36	36	42	1051	30
90Z	-	5073.3	641	1114	-	21	27	1051	15
91X	114.40	-	-	1115	12	-	-	1178	12
91Y	114.45	5073.6	642	1115	36	36	42	1052	30
91Z	-	5073.9	643	1115	-	21	27	1052	15
92X	114.50	-	-	1116	12	-	-	1179	12
92Y	114.55	5074.2	644	1116	36	36	42	1053	30
92Z	-	5074.5	645	1116	-	21	27	1053	15
93X	114.60	-	-	1117	12	-	-	1180	12
93Y	114.65	5074.8	646	1117	36	36	42	1054	30
93Z	-	5075.1	647	1117	-	21	27	1054	15
94X	114.70	-	-	1118	12	-	-	1181	12
94Y	114.75	5075.4	648	1118	36	36	42	1055	30
94Z	-	5075.7	649	1118	-	21	27	1055	15
95X	114.80	-	-	1119	12	-	-	1182	12
95Y	114.85	5076.0	650	1119	36	36	42	1056	30
95Z	-	5076.3	651	1119	-	21	27	1056	15
96X	114.90	-	-	1120	12	-	-	1183	12
96Y	114.95	5076.6	652	1120	36	36	42	1057	30
96Z	-	5076.9	653	1120	-	21	27	1057	15
97X	115.00	-	-	1121	12	-	-	1184	12
97Y	115.05	5077.2	654	1121	36	36	42	1058	30
97Z	-	5077.5	655	1121	-	21	27	1058	15
98X	115.10	-	-	1122	12	-	-	1185	12
98Y	115.15	5077.8	656	1122	36	36	42	1059	30
98Z	-	5078.1	657	1122	-	21	27	1059	15
99X	115.20	-	-	1123	12	-	-	1186	12
99Y	115.25	5078.4	658	1123	36	36	42	1060	30
99Z	-	5078.7	659	1123	-	21	27	1060	15
100X	115.30	-	-	1124	12	-	-	1187	12
100Y	115.35	5079.0	660	1124	36	36	42	1061	30
100Z	-	5079.3	661	1124	-	21	27	1061	15
101X	115.40	-	-	1125	12	-	-	1188	12
101Y	115.45	5079.6	662	1125	36	36	42	1062	30
101Z	-	5079.9	663	1125	-	21	27	1062	15
102X	115.50	-	-	1126	12	-	-	1189	12
102Y	115.55	5080.2	664	1126	36	36	42	1063	30

TABLE 2-1 (CONTINUED)

CHANNEL PAIRING				DME PARAMETERS					
				INTERROGATION				REPLY	
					PULSE CODES				
						DME/P MODE			
DME	VHF FREQ.	MLS ANGLE FREQ.	MLS CH	FREQ.	DME/N	IA	FA	FREQ.	PULSE CODES
No	MHz	MHz	No	MHz	us	us	us	MHz	us
102Z	-	5080.5	665	1126	-	21	27	1063	15
103X	115.60	-	-	1127	12	-	-	1190	12
103Y	115.65	5080.8	666	1127	36	36	42	1064	30
103Z	-	5081.1	667	1127	-	21	27	1064	15
104X	115.70	-	-	1128	12	-	-	1191	12
104Y	115.75	5081.4	668	1128	36	36	42	1065	30
104Z	-	5081.7	669	1128	-	21	27	1065	15
105X	115.80	-	-	1129	12	-	-	1192	12
105Y	115.85	5082.0	670	1129	36	36	42	1066	30
105Z	-	5082.3	671	1129	-	21	27	1066	15
106X	115.90	-	-	1130	12	-	-	1193	12
106Y	115.95	5082.6	672	1130	36	36	42	1067	30
106Z	-	5082.9	673	1130	-	21	27	1067	15
107X	116.00	-	-	1131	12	-	-	1194	12
107Y	116.05	5083.2	674	1131	36	36	42	1068	30
107Z	-	5083.5	675	1131	-	21	27	1068	15
108X	116.10	-	-	1132	12	-	-	1195	12
108Y	116.15	5083.8	676	1132	36	36	42	1069	30
108Z	-	5084.1	677	1132	-	21	27	1069	15
109X	116.20	-	-	1133	12	-	-	1196	12
109Y	116.25	5084.4	678	1133	36	36	42	1070	30
109Z	-	5084.7	679	1133	-	21	27	1070	15
110X	116.30	-	-	1134	12	-	-	1197	12
110Y	116.35	5085.0	680	1134	36	36	42	1071	30
110Z	-	5085.3	681	1134	-	21	27	1071	15
111X	116.40	-	-	1135	12	-	-	1198	12
111Y	116.45	5085.6	682	1135	36	36	42	1072	30
111Z	-	5085.9	683	1135	-	21	27	1072	15
112X	116.50	-	-	1136	12	-	-	1199	12
112Y	116.55	5086.2	684	1136	36	36	42	1073	30
112Z	-	5086.5	685	1136	-	21	27	1073	15
113X	116.60	-	-	1137	12	-	-	1200	12
113Y	116.65	5086.8	686	1137	36	36	42	1074	30
113Z	-	5087.1	687	1137	-	21	27	1074	15
114X	116.70	-	-	1138	12	-	-	1201	12
114Y	116.75	5087.4	688	1138	36	36	42	1075	30
114Z	-	5087.7	689	1138	-	21	27	1075	15
115X	116.80	-	-	1139	12	-	-	1202	12
115Y	116.85	5088.0	690	1139	36	36	42	1076	30
115Z	-	5088.3	691	1139	-	21	27	1076	15
116X	116.90	-	-	1140	12	-	-	1203	12
116Y	116.95	5088.6	692	1140	36	36	42	1077	30
116Z	-	5088.9	693	1140	-	21	27	1077	15
117X	117.00	-	-	1141	12	-	-	1204	12
117Y	117.05	5089.2	694	1141	36	36	42	1078	30
117Z	-	5089.5	695	1141	-	21	27	1078	15
118X	117.10	-	-	1142	12	-	-	1205	12
118Y	117.15	5089.8	696	1142	36	36	42	1079	30

TABLE 2-1 (CONTINUED)

CHANNEL PAIRING				DME PARAMETERS					
				INTERROGATION				REPLY	
					PULSE CODES				
DME No	VHF FREQ. MHz	MLS ANGLE FREQ. MHz	MLS CH No	FREQ. MHz	DME/N us	DME/P MODE IA us	DME/P MODE FA us	FREQ. MHz	PULSE CODES us
118Z	-	5090.1	697	1142	-	21	27	1079	15
119X	117.20	-	-	1143	12	-	-	1206	12
119Y	117.25	5090.4	698	1143	36	36	42	1080	30
119Z	-	5090.7	699	1143	-	21	27	1080	15
120X	117.30	-	-	1144	12	-	-	1207	12
120Y	117.35	-	-	1144	36	-	-	1081	30
121X	117.40	-	-	1145	12	-	-	1208	12
121Y	117.45	-	-	1145	36	-	-	1082	30
122X	117.50	-	-	1146	12	-	-	1209	12
122Y	117.55	-	-	1146	36	-	-	1083	30
123X	117.60	-	-	1147	12	-	-	1210	12
123Y	117.65	-	-	1147	36	-	-	1084	30
124X	117.70	-	-	1148	12	-	-	1211	12
**124Y	117.75	-	-	1148	36	-	-	1085	30
125X	117.80	-	-	1149	12	-	-	1212	12
**125Y	117.85	-	-	1149	36	-	-	1086	30
126X	117.90	-	-	1150	12	-	-	1213	12
**126Y	117.95	-	-	1150	36	-	-	1087	30

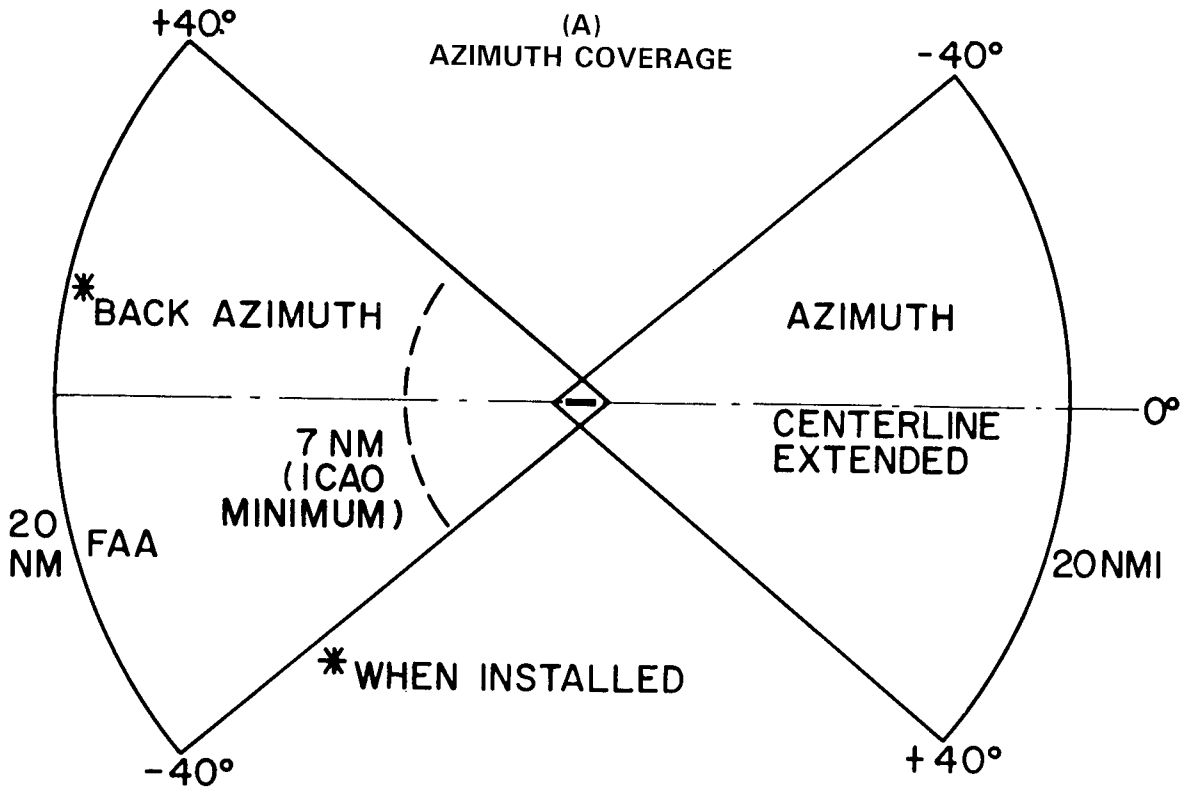
* These channels are reserved exclusively for national allotments.
** These channels may be used for national allotment on a secondary basis. The primary reason for reserving these channels is to provide protection for the Secondary Surveillance Radar (SSR) system.
▽ 1080 MHz is not scheduled for assignment to ILS Service. The associated DME operating channel No. 17X may be assigned to the emergency service.

- Laterally, 40° on either side of the runway.
- In range, to a distance of at least 20 NM.

The EL is analogous to the glide slope facility of the ILS, except that the EL provides for a wide selection of glide path angles by the pilot up to 15°. The signal coverage of the EL extends through the area covered by the AZ, as shown in Figure 2-3B. EL coverage up to 30° is allowed in the signal format.

Precision Distance Measuring Equipment (DME/P)

DME/P provides range information. The DME/P is compatible with standard navigation DME but has improved accuracy and additiona channel capabilities. It is usually collocated wit the AZ and consists of a beacon transponder tha operates in the frequency band 979 to 1143 MH (see Table 2-1). It responds to a beacon inte rogation made by an aircraft interrogator. Th main change in the MLS DME/P from the cor ventional navigation DME is that the accurac (which in the final approach mode is ± 100 fee has been improved so as to provide increase operational capability. It should be noted tha the DME/P also has an initial approach mod which is less accurate than the final approac mode but more accurate than conventiona DME.



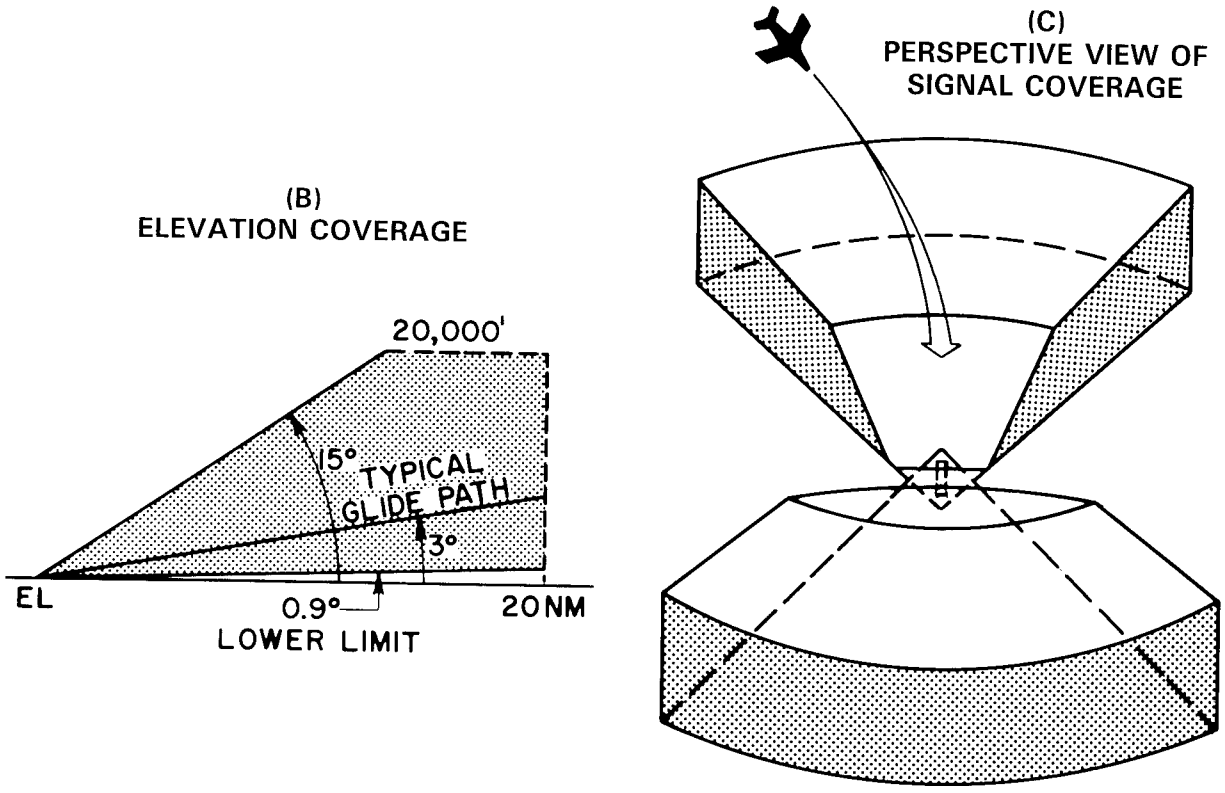


Figure 2-3A, B & C: Coverage Volumes

In operation, a DME/P channel will be paired with the MLS azimuth and elevation channel when the selection of a particular MLS is made by the pilot. A complete listing of the 200 paired channels of the DME/P with the MLS angle channels is contained in an FAA standard (FAA-STD-022b, MLS Interoperability and Performance Requirements). The DME/P is an integral part of the MLS and will be installed at all MLS facilities to provide range information. Figure 2-3C is a perspective view of the volume of airspace covered by the AZ, BAZ, and EL signals. The DME/P will usually be omnidirectional.

Back Azimuth

A Back Azimuth (BAZ) is optional and may be installed at the opposite runway end to provide lateral guidance for missed approach and departure navigation. The BAZ Azimuth transmitter is essentially the same as the AZ transmitter. However, the equipment transmits at a somewhat lower data rate because the guidance accuracy requirements are not as stringent as for the landing approach. The equipment operates on the same frequency as the approach azimuth but at a different time in the transmission sequence.

The BAZ is somewhat analogous to the back course of an ILS localizer, but its purpose is to provide guidance for departures and missed approaches. ICAO has specified as a minimum a 7 NM range for the BAZ, as compared to 20 NM for the AZ. FAA installations with BAZ will be those with a need for opposite direction approaches. In such cases, the installations will have separate DME/P and EL stations for each approach direction. Only one DME/P and one EL station will be switched on at a time.

The AZ and BAZ stations will interchange functions when the approach system for the opposite direction is in use. To provide this bidirectional capability, the BAZ for FAA installations will normally provide a 20 NM coverage. In special cases, a BAZ might be installed solely to provide departure and missed approach guidance. This might be desired where terrain or other constraint not only require such guidance but preclude the establishment of an approach from the opposite direction.

Antenna Options

A variety of antenna options are available. The antenna configurations can be varied to meet the coverage needs of each site. The azimuth coverage can be as narrow as ± 10° or as broad as ± 60° from the runway centerline. It can also be varied on either side. For example, at Valdez, Alaska, the coverage extends 40° to the South of the runway centerline, but only 10° to the North because of nearby mountains.

MLS antenna siting configurations can be varied to meet operational requirements. For example, an MLS has been installed at Jasper, Alberta, Canada, with the DME element collocated with the EL instead of the AZ element, in order to reduce the shadowing effects of a nearby mountain. MLS installations for heliports may have their AZ, EL, and DME elements collocated to save space.

Table 2-2 defines the six antenna options which are specified in the FAA procurement contract.

Signal Format

MLS can operate on any one of 200 channels from 5031 MHz to 5090.7 MHz, inclusive (Table 2-1). This is expected to be enough to fulfill any possible future need for MLS channels. In any MLS, the AZ, BAZ, and EL stations all transmit on the same frequency. Basic and auxiliary data are also transmitted on the same frequency, as illustrated in Figure 2-4. The DME/P transmits on a paired frequency in L-band.

The MLS signal format is a very flexible structure which has the potential to transmit the signals from the various stations in any desired order. A preamble at the beginning of each time slot tells the airborne processor which function will be transmitted next. As soon as the processor decodes the message in this time slot, it waits for the preamble for the next time slot.

TABLE 2-2: ANTENNA OPTIONS

	AZIMUTH GUIDANCE		ELEVATION GUIDANCE		TYPICAL APPLICATION	
TYPE	BEAMWIDTH	SCAN ANGLE	BEAMWIDTH	SCAN ANGLE	RUNWAY	ENVIRONMENT
Type I	2°	±40°	1.5°	0.9° to 15°	8-9000 ft	level terrain
Type II	2°	±40°	1°	0.9° to 15°	8-9000 ft	rising/irregular terrain
Type III	1°	±40°	1.5°	0.9° to 15°	14-15000 ft	level terrain
Type IV	1°	±40°	1°	0.9° to 15°	14-15000 ft	rising/irregular terrain
Type V	1°	±10°	1°	0.9° to 15°	14-15000 ft	large reflecting objects
Type VI	1°	±60°	1°	0.9° to 15°	14-15000 ft	rising/irregular terrain noise abatement

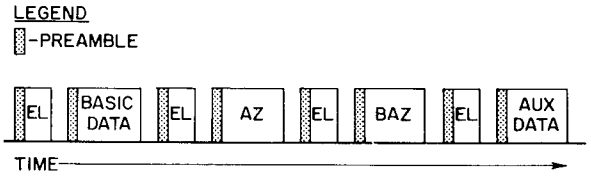


Figure 2-4: Time Multiplexed Signal Format

Data

MLS facilities transmit two categories of data, basic and auxiliary. The format is flexible; the data is in digital or alphanumeric form and consists of a number of data words which can be modified as operational experience is gained.

Basic data includes digital data which is necessary for the processing of angle functions. It also includes station identification, and is transmitted at least once per second.

Auxiliary data includes all data necessary to establish the geometry of the system, and is transmitted once per second.

Only a small portion of the auxiliary data has yet been defined. Possible future uses include the transmission of way point coordinates, meteorological information, runway status, and other supplementary information to the aircraft.

Angular Measurement

Angular measurement involves both Azimuth and Elevation. These are discussed in the following paragraphs.

Azimuth

The AZ antenna generates a narrow, vertical, fan-shaped beam as shown in Figure 2-5A and sweeps it "TO" and "FRO" across the coverage area shown in Figure 2-5B. At the beginning of the AZ time slot, the AZ preamble is transmitted; then the "TO" scan starts. At the end of this scan, there is a pause before the "FRO" scan starts.

During this scan cycle, the aircraft receives a "TO" pulse and a "FRO" pulse. The time between these two pulses is then measured. It can be seen from Figure 2-5B that the elapsed time between receipt of the "TO" and "FRO" pulse gives the angular location of the aircraft.

In Figure 2-5B, the full scanning capability of MLS (± 62°) is shown in dotted lines. The normal scan of most installations (± 40°) is shown in solid lines. Some installations may scan ± 60° where broad coverage is needed. On the other hand, some may scan as low as ± 10° at locations where special siting or multipath problems exist.

Elevation

The same angular measurement principle used for determining azimuth is used for determining the elevation angle. The EL antenna generates a narrow horizontal, fan-shaped beam and sweeps it through the coverage area shown in

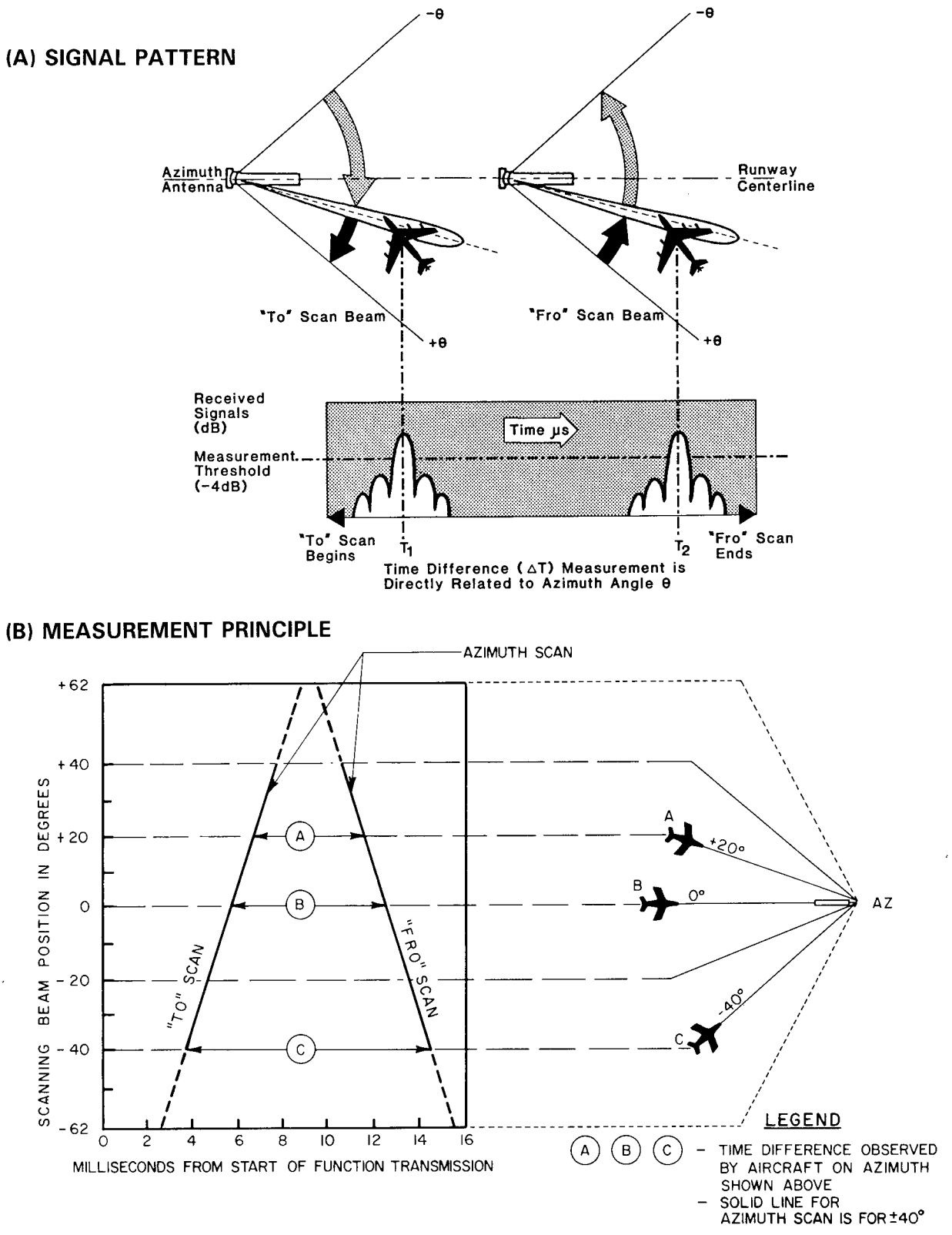


Figure 2-5A & B: Signal Pattern and Angular Measurement Principle

'igure 2-3B. The scanning conventions for ap-
›roach elevation guidance functions are shown
n Figure 2-6.

During the elevation scan cycle the aircraft eceives a "TO" pulse from the upward scan and ı "FRO" pulse from the downward scan. The :lapsed time between the two pulses determines he elevation angle of the aircraft, and thus its lisplacement from the glide path angle as se-ected by the pilot.

Back Azimuth

The BAZ equipment is identical to the AZ. However, the scan is limited to ± 40°.

MLS Ground Systems

Figure 2-7 are photographs of typical MLS ground system hardware: Elevation, Azimuth and DME/P Station.

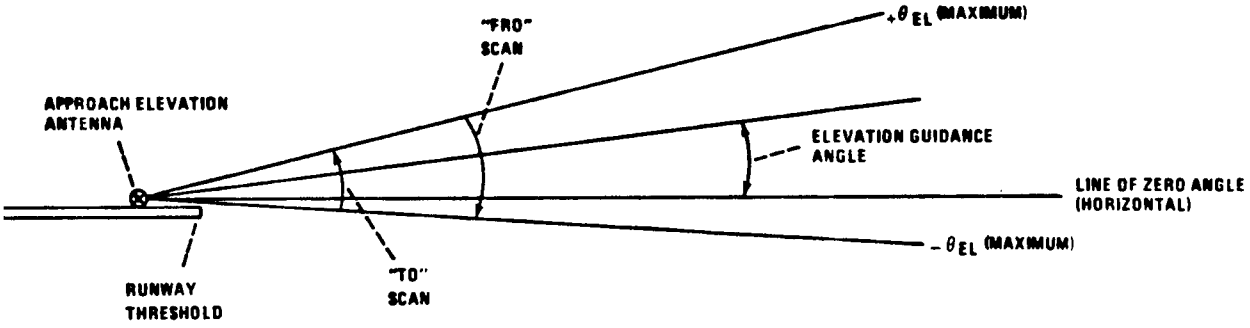
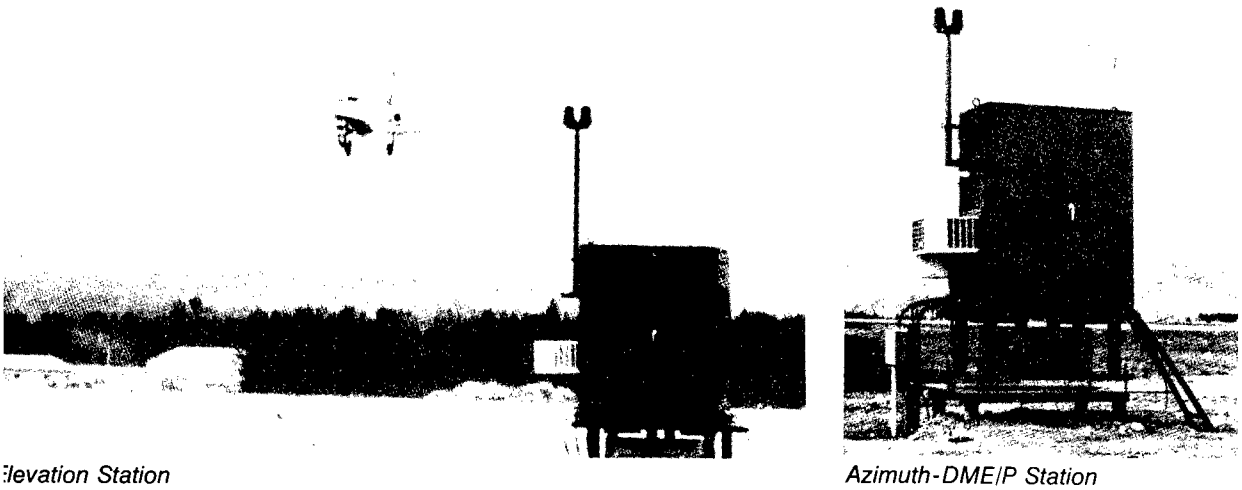


Figure 2-6: Scanning Conventions for Approach Elevation Guidance Functions



:levation Station

Azimuth-DME/P Station

Figure 2-7: Ground System Hardware

MLS OPERATIONAL CAPABILITIES

The type of avionics installed in an aircraft will determine its MLS operational capability. For this handbook, the three distinct types of avionics capabilities will be explained.

- Basic Approach Capability
- Segmented Approach Capability
- Curved Approach Capability

Basic Approach

The basic equipment layout is illustrated in Figure 2-8, together with typical approach capabilities, which include DME arcs, selectable glide paths, and straight in approaches on or off the runway centerline. The control panels for MLS receivers allow the pilot to select the frequency, the azimuth (approach course) and the elevation (glide path) angle.

Segmented Approach

In order to obtain a segmented approach capability, the equipment configuration requires the addition of a computer. The equipment layout for this capability is illustrated in Figure 2-9. This allows the pilot to set up precise way points within MLS coverage for the additional capability of making complex approaches.

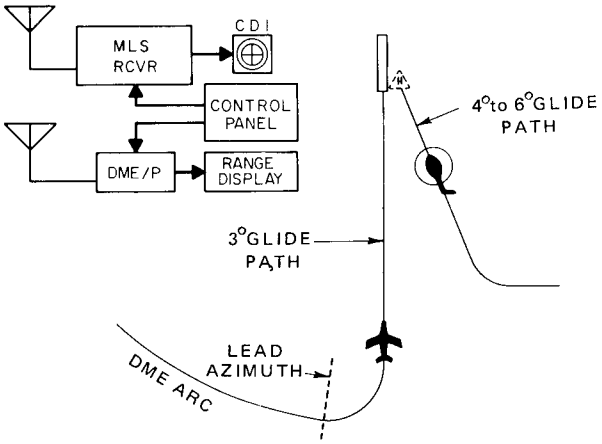


Figure 2-8: Basic Avionics and Capabilities

Curved Approach

The curved approach capability requires th addition of relatively expensive and sophisticate avionics equipment. If the computer defines th turn path with a specified radius of turn, curve approaches such as the flight tracks shown i Figure 2-10 can be flown. In the more so phisticated avionics installations, the compute functions may be included in the flight manage ment system of the aircraft, driving a flight direc tor or a CRT navigational display of an Elec tronic Flight Instrumentation System (EFIS), a diagrammed in Figure 2-10.

Any of the equipment layouts shown in Fig ures 2-8, 2-9, or 2-10 can include an autocoupler autopilot to provide the additional capability o

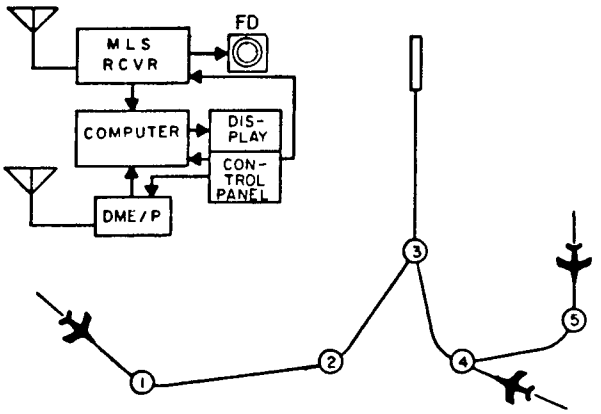


Figure 2-9: Segmented Approach Capability

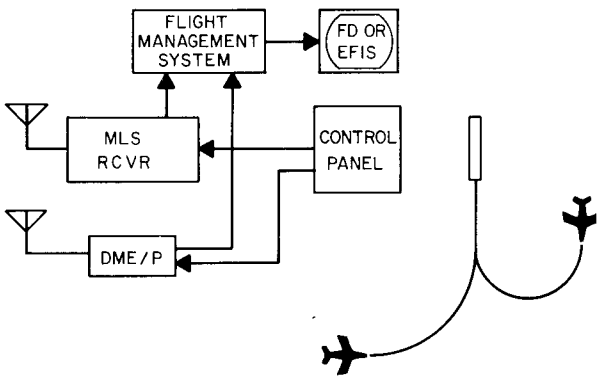


Figure 2-10: Curved Approach Capability

naking an automatic landing. The approach ninima established will depend mainly on the ·equired redundancy of the ground equipment ınd avionics.

The operational criteria to support curved and ;egmented approaches is now under develop- nent. Over 400 curved MLS approaches have ɔeen flown in support of this development, using ;uidance from a flight director.

Avionics Equipment

The Avionics equipment for each of the three evels of MLS capability are:

1. **Basic Capability**

   - MLS Receiver
   - DME/P Interrogator
   - Cockpit Display Indicator
   - Range Display
   - Control Panel
   - MLS and DME/P Antenna
   - Interconnecting Wiring

2. **Segmented Approach Capability**

   - MLS Receiver
   - Flight Display
   - Computer Display
   - MLS and DME/P Antenna
   - DME/P Interrogator
   - Computer
   - Control Panel
   - Interconnecting Wiring

3. **Curved Approach Capability**

   - MLS Receiver
   - Flight Management System
   - MLS and DME Antenna
   - Flight Display or Electronic Flight Instrumentation System
   - DME/P Interrogator
   - Control Panel
   - Interconnecting Wiring

Basic MLS Avionics

Figure 2-11 is a photograph of the basic MLS avionics equipment: MLS receiver, control panel and antenna.

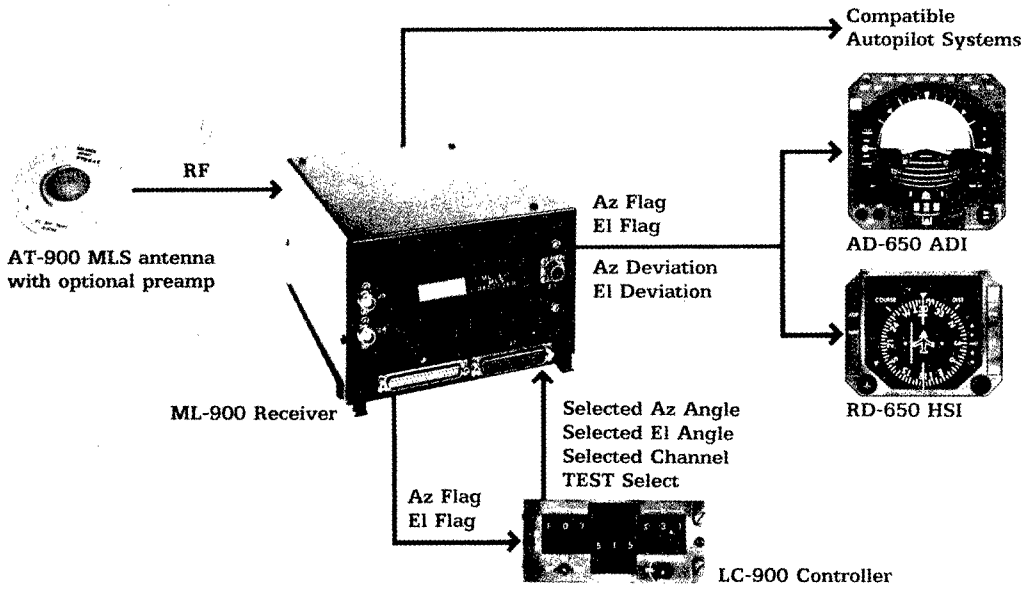


Figure 2-11: MLS Avionics Equipment

MLS SITING CONSIDERATIONS

The present criteria for the siting of MLS systems on a runway, or at an airport where MLS service is desired, is contained in FAA Report DOT/FAA/PM-83/2, Siting Criteria for the Microwave Landing System (MLS), February 1983. That document is currently being updated and the revised version is of the sitting criteria is discussed below.

Weatherproof

The electronic equipment for the AZ, BAZ, EL, and DME/P stations will be self-contained in weatherproof enclosures which normally will be mounted directly at the antenna sites. No special shelters will be required.

Equipment Locations

The equipment normally will be located on the airport as described in the following paragraphs.

Azimuth (AZ)

The location for the AZ will be on the extended runway centerline between 500 and 2,000 feet beyond the stop end of the runway, as shown in Figure 2-12. If a location on the centerline is not feasible, the AZ station should be located within the alternate siting area shown in Figure 2-12. The penalty could be a slightly higher Decision Height (DH). Care must be taken to keep the AZ station clear of jet blast areas.

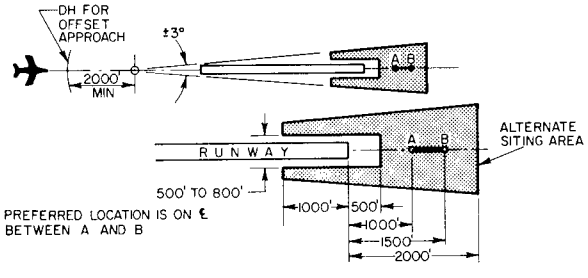


Figure 2-12: Preferred and Alternate Locations for Approach Azimuth Station

Elevation (EL)

The desired location for the EL station is as close as possible to the runway centerline consistent with obstacle clearance criteria (nominally 250 feet) in order to minimize the glide path curvature due to the conical antenna pattern (see Figure 2-13). The distance from the threshold of the landing runway should be chosen to provide for a specific Approach Reference Datum (ARD) height and minimum glide path. If the minimum is 3 and the ARD is 50 feet, for example, this will place the EL antenna approximately 820 feet from the runway threshold. A lower ARD height might be used for aircraft landing on a short runway. A higher minimum glide slope might be used for STOL aircraft.

To avoid interference or shadowing of the elevation signals received by aircraft on final approach, the EL station normally should be sited on the opposite side of the runway from the entry taxiway used by departing aircraft.

DME/P

The preferred location of the DME/P is at the AZ site.

Back Azimuth (BAZ)

When installed, the BAZ should be located on the extended runway centerline, between 500 and 2,000 feet from the approach end of the runway

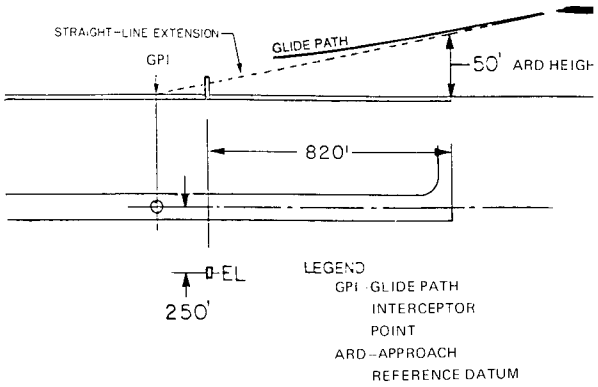


Figure 2-13: Elevation Station Location

Critical Areas

Critical areas are areas around the MLS antennas where any vehicles (including aircraft), parked or moving, may cause unacceptable interference with the transmitted navigation guidance signals.

The MLS is less vulnerable than the ILS to signal reflections; signal blockage (shadowing) is the main concern. For straight in approaches, the critical area of the MLS is substantially smaller than that of the ILS.

When used for segmented and curved approaches, the critical areas of the MLS may be larger. Work is underway to determine critical areas for these applications. See Figures 2-14 and 2-15.

Shadowing

To minimize the effects of shadowing of the EL beam by aircraft awaiting departure, it is usually desirable to site the EL station on the opposite side of the runway from the entry taxiway, as mentioned earlier. Another factor which should be considered is the shadowing of the EL beam by nearby buildings or other obstacles. In some cases the effects of shadowing can be reduced by adjustment of the EL station location, in order to place the shadows in a non-critical portion of the coverage area. The simplicity of siting an EL station facilitates this solution. Figure 2-16 shows a shadowing area.

Extended Coverage

As shown in Figure 2-3A, approach coverage normally will be ± 40° on either side of the extended runway centerline. In special cases, this can be expanded to ± 60°. Where it is desirable to provide guidance to more than one runway, the azimuth coverage can be skewed as shown in Figure 2-17. A maximum skew of 20° is allowed.

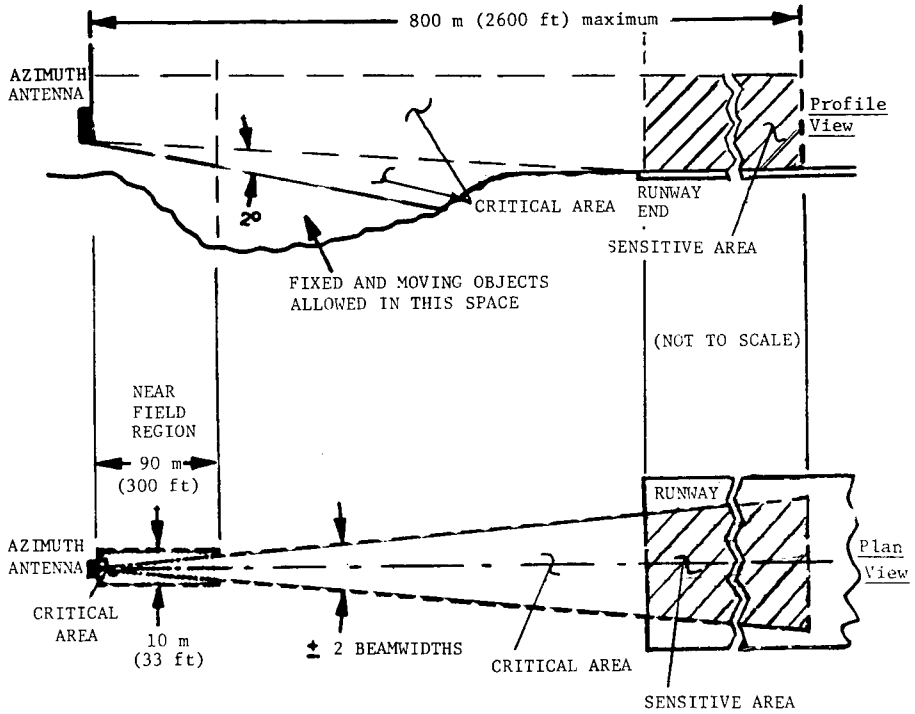


Figure 2-14: Typical Azimuth Critical and Sensitive Areas

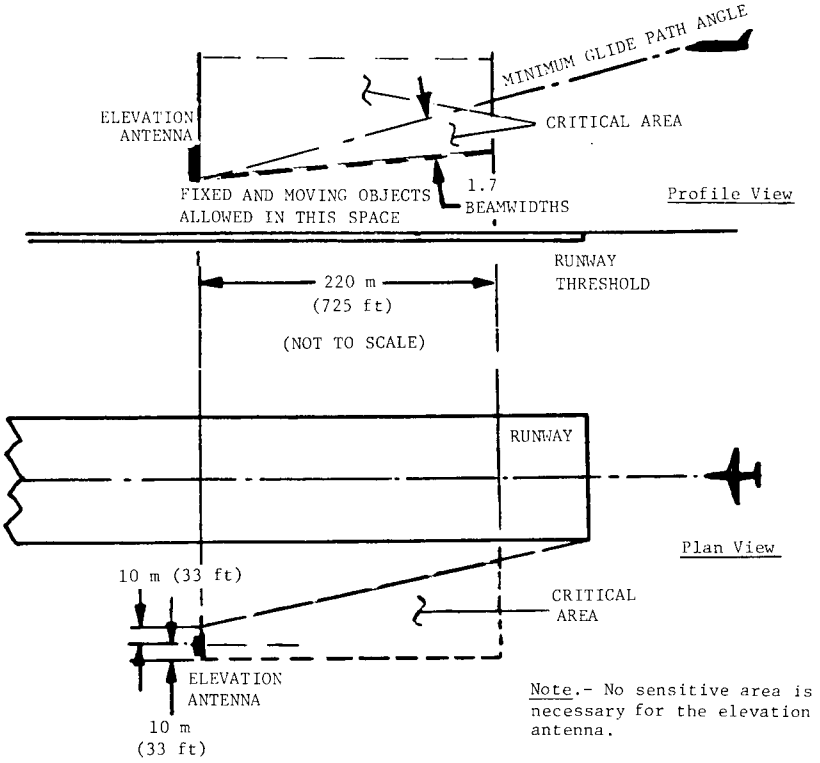


Figure 2-15: Typical Elevation Critical Areas

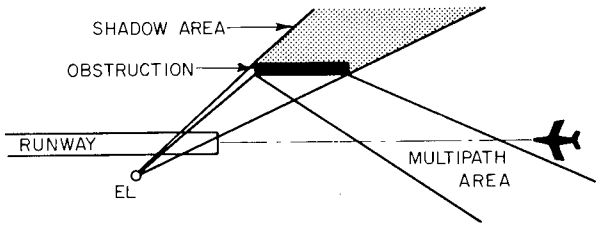


Figure 2-16: Shadowing and Multipath Areas

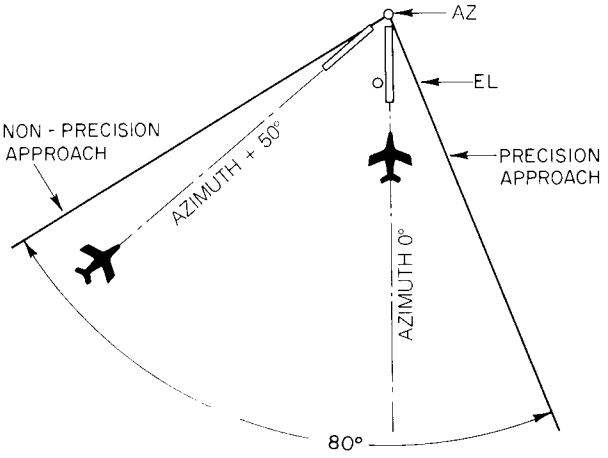


Figure 2-17: Skewed Coverage

Collocation with ILS

During the transition period, MLS will be in stalled at many runways already equipped with ILS. In this case, care must be taken to avoic mutual interference between the ILS and MLS The situation will vary with the type of ILS an tennas being used. However, the relatively smal size of the MLS equipment will usually allow suf ficient flexibility to provide a satisfactory in stallation within the location criteria previously described. In most cases it will be desirable fo the final approach course of the MLS to coincid with that of the ILS. Azimuth and Elevation sta tion considerations are discussed in the follow ing two sections.

Azimuth Station

The Azimuth or Back Azimuth station some times can be installed so that its antenna look over the top of the ILS localizer, as shown i Figure 2-18. In this case the MLS antenna mus be high enough to avoid being shadowed by th localizer antenna structure, but low enough t

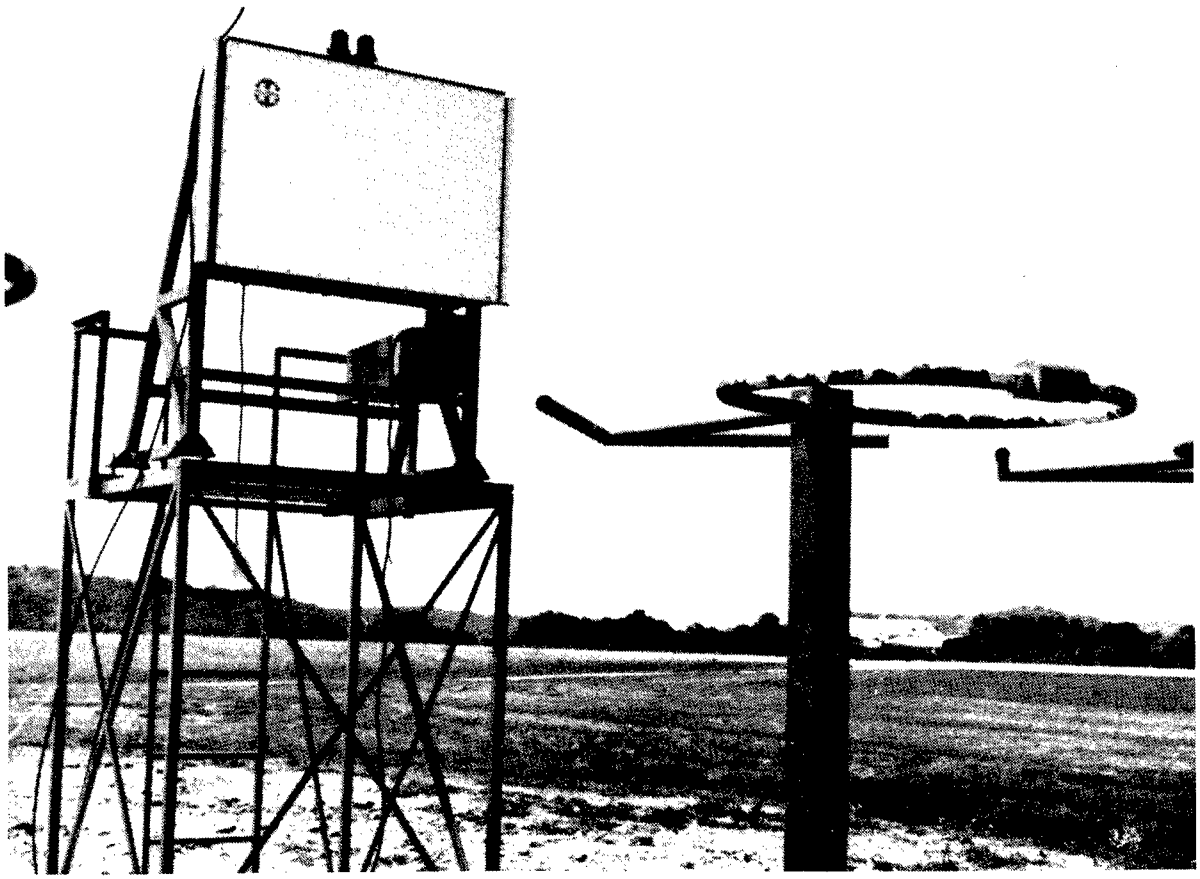


Figure 2-18: Collocated AZ/Localizer Antenna

avoid any penetration of the obstacle clearance surface.

In some cases it has been possible to locate the MLS Azimuth station in front of the ILS localizer antenna. In this case it must not be sited between the localizer antenna and its monitor. The Azimuth station should be centered precisely on the localizer approach course so that it will not produce an unequal effect on the 90/150 cycle signals of the localizer.

If neither of the two locations described above is suitable, the next choice could be an offset azimuth, as shown in Figure 2-19. Possible disadvantages here would be:

- A slightly higher Decision Height.
- Lack of coincidence between final approach paths of aircraft making MLS or ILS approaches. However, a computer centerline approach path, using the wide proportional coverage of MLS, would minimize these disadvantages.

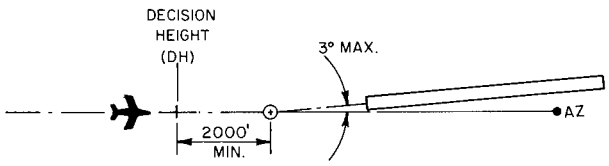


Figure 2-19: Offset Approach

Elevation Station

The ILS glide path is formed by reflection of the signals from the ground surface in front of the antenna. Consequently, in effect, the ILS glide path radiates from the base of the glide slope antenna. However, the elevation beam of

an MLS radiates from the phase center of the antenna, which may be as much as nine feet off the ground. For this reason, the MLS elevation station can be up to 180 feet closer to the runway threshold than the ILS glide slope antenna, if coincidence of the ILS and MLS threshold crossing heights is desired. This principle is shown in Figure 2-20.

In any case, the MLS station should not be located between the ILS glide slope antenna and its monitor. In some cases the MLS elevation station has been located directly in front of the ILS glide slope monitor in order to have minimum effect on the glide slope signals. The field monitor for the elevation station need not be located directly in front of the station, but can be offset up to 20° farther away from the runway, as shown in Figure 2-21.

Siting at Heliports

The MLS siting considerations previously discussed for airports also apply to heliports, with the following exceptions:

- Unlike fixed-wing aircraft, helicopters accomplish their final deceleration in the air instead of on a runway. This characteristic affects the placement of MLS facilities for heliports. In the past, helicopters have typically made instrument approaches at airspeeds of 60 to 90 knots.

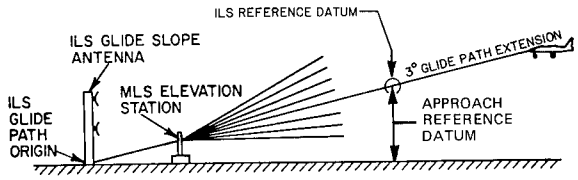


Figure 2-20: Relative Location of Elevation Station and ILS Glide Slope Antenna for Coincidental Glide Paths

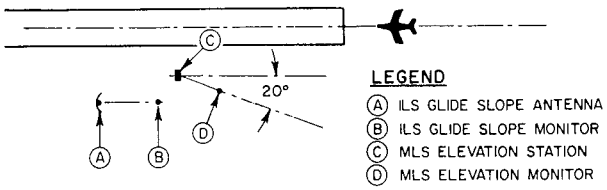


Figure 2-21: Glide Slope and Monitor Locations

As part of FAA's Rotorcraft Master Plan, el forts are underway to certify helicopters at lowe approach speeds leading eventually to a full decelerating approach under IFR. A few hel copters have been certified for down to 40 knot Plans are underway to further improve the lo speed handling characteristics of helicopter This will allow certification of helicopters a lower and lower IFR airspeeds, thereby allow ing higher approach angles.

- Because heliports tend to be located i limited land areas, many sites will require tha the AZ, EL, and DME/P facilities be collocatec The actual siting is affected by the relationshi between elevation angle, DH, and approac speed.
- In many cases, a somewhat higher eleva tion angle will avoid obstacles and thus perm the DH to be lowered. However, as the eleva tion angle is increased, an angle will be reache whereby the helicopter will have to leave the glid path in order to have sufficient distance to de celerate to hover speed before landing. This ma necessitate siting the MLS (or at least the EL sta tion) in front of the helipad as shown in Figur 2-22.
- Higher approach speeds increase th deceleration distance, and can be accommodate by raising the DH or by increasing the spacin between the EL and the helipad. With a give DH, a higher elevation angle will tend to increas the spacing. With a given elevation angle, a lowe DH also will tend to increase the spacin required.
- To obtain azimuth guidance all the way t the helipad, the AZ should be behind the helipa as shown in Figure 2-22.
- Other exceptions of heliport siting are sti being considered.

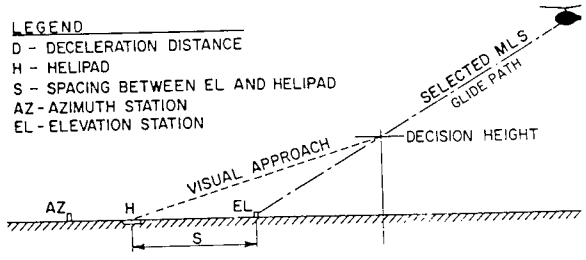


Figure 2-22: Split-Site MLS for Heliport (Note: Thi is not a collocated AZ/EL station for heliport.)

MLS MAINTENANCE AND MONITORING

The maintenance and monitoring of the MLS is an important part of MLS operation. This section provides a look at the maintenance approach and system monitoring concepts.

'80s Maintenance Program

During the development of the MLS, the FAA has been developing the '80s Maintenance Program, which is designed to reduce outages as well as lower maintenance costs. MLS will be the first system designed from the start to utilize this program, which includes the following key features:

- Unattended operation of facility.
- Continuous automatic remote monitoring.
- Maximum use of modular, solid-state electronics.
- Remote control and status information.
- 22,500 hour-MTBO (Goal: one maintenance visit every three months).
- Remote diagnosis and fault detection.
- Automatic record keeping.
- On site replacement of defective modules.
- Automatic update of facility status, to pilots.

The advantages of the '80s Maintenance Program include a significant reduction in the time spent in travel, maintenance, and record keeping. These factors are expected to allow more effective use of a smaller number of maintenance personnel, operating from a smaller number of maintenance centers.

System Monitoring

Each MLS station is supported by two forms of monitoring: an Executive Monitor and a Remote Maintenance Monitor.

Executive Monitoring

The executive monitoring functions are shown in Figure 2-23. The integral monitor samples the signals radiated from each element of the antenna array in order to check the characteristics of the signal in space. A field monitor examines the signals at a point in front of the antenna to take account of physical movement of the antenna itself and of some environmental effects on the array. Both integral and field monitors detect such conditions as:

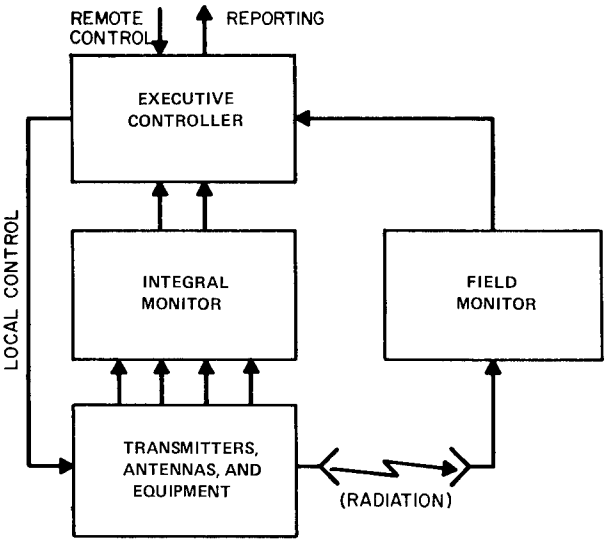


Figure 2-23: Executive Monitoring

- Out-of-tolerance shift of guidance signal.
- Error in preamble or data.
- Low transmitter power.
- Timing error in signal format.
- Synchronization error in the division multiplexing.

If any of these parameters are out of tolerance, the executive monitor automatically shuts down the station and initiates an alarm.

Remote Maintenance Monitoring

All new electronic systems being procured by the FAA under the NAS Plan are being designed to operate with Remote Maintenance Monitoring. This concept is made possible through recent developments in networking and microprocessor technology leading to the development of the Remote Maintenance Monitoring System (RMMS). The MLS is one of the first systems designed from the start to operate with the RMMS.

Figure 2-24 shows the relationship between the various elements of the RMMS. Each MLS will have a Remote Monitoring Subsystem (RMS) integrated into its equipment. The RMS serves as the data and control function interface between the MLS and the other elements of RMMS.

The RMS is connected through the National Interfacility Communications System (NICS) to the Maintenance Processor Subsystem (MPS), which is the heart of the RMMS. In some cases, a Remote Monitoring Subsystem Concentrator (RMSC) may be installed between the RMS and the MPS. The RMSC multiplexes data between several RMSs and the MPS. The MPS is a data processor and is located either in an Air Route Traffic Control Center or in a Sector Maintenance Office. The RMS is polled on a regular basis by the MPS for time critical (alarm) messages, and normally once in eight hours for certification reports from each RMS. The MPS is connected to a Maintenance Monitor Console (MMC), which displays the detailed status of the monitored facilities. The MMC also provides a means of remotely diagnosing equipment malfunctions, as well as commanding a performance

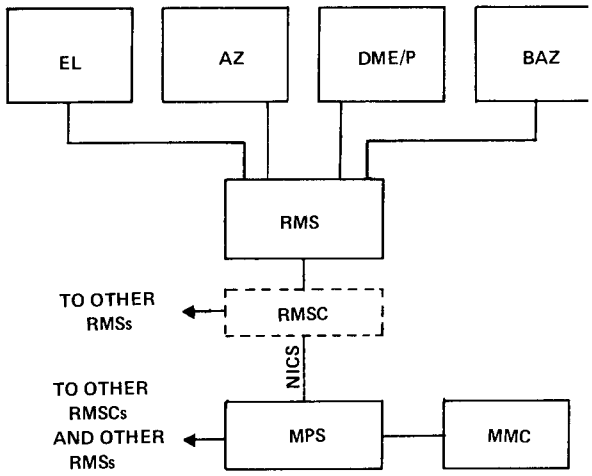


Figure 2-24: Remote Maintenance Monitoring System

check or other action. These commands may b initiated at any time.

When an alarm is received at the MMC, technician can probe the system to determin which module has failed. A replacement modul can then be taken to the site for a quick restora tion of the facility to normal operation.

INDUSTRY PERSPECTIVE

The acceptance of TRSB MLS by ICAO as the international standard to replace ILS and the current implementation of the MLS program in the U.S. has raised industry interests in MLS worldwide. There is a large and operative market within the U.S. for industry to develop, sell and provide MLS products and equipment. The total requirement must be filled within the next 15 years.

MLS Ground Systems Market

There are three procurements planned for the acquisition of the 1,250 MLS ground systems by FAA. The first contract has been awarded to the Hazeltine Corporation for 208 systems. The second contract should be awarded in late 1986 or early 1987. This will be for between 600 and 800 systems (joint FAA/DOD requirements), and the third will follow later.

There are several major market segments fo MLS within the U.S. These include:

- Federal Program: The DOT/FAA ha identified a civil aviation requirement for 1,25 MLS systems. These will be provided by FA using Federal funds under an F&E program.
- Nonfederal: A variety of programs exis which include certain state and municipal re quirements, and corporate and private users These requirements pertain to both airports an heliports. Many of these programs do not qualif for Federal grants or support. The state an municipal needs relate to potential funding unde the Airport Improvement Program (AIP). A conservative market estimate indicates a require ment for several hundred MLS systems in thi area over the next 15 years.
- DOD: The DOD has requirements fo both Fixed Base and Tactical MLS ground sta tions. The fixed base systems will be procure

is add ons to the FAA procurement. DOD's current estimate is for 326 systems. A separate program to obtain tactical MLSs is being led by the JSAF. Current estimates are for the procurement of 252 tactical MLSs to meet DOD requirements.

Airborne Avionics Equipment Market

Aircraft must be equipped with new MLS avionics to utilize MLS. The avionics required to fly MLS, civil or military, are much the same. With the transition from ILS to MLS scheduled for completion over the next 15 years, a large market for MLS avionics hardware exists.

At the present time, there are only two production suppliers of civil MLS avionics in the U.S. These are Sperry Flight Systems and Benlix Avionics. They both offer cabin class airline quality products. There are also several other avionics manufacturers who are engaged in the development of receivers that will be needed to service the full range of civil requirements.

The FAA's planned implementation schedule should motivate private industry to respond to users' needs as it has traditionally done. Given the tremendous capability that MLS will provide, and the ease of installation, it is expected that user demand will develop rapidly.

Looking at the overall avionics requirements over the next 15 years, there is a significant market potential in the following areas:

- Air Transport Aircraft — The segment of air carrier and cargo operators involving heavy jet aircraft who will require sophisticated equipment that will provide for segmented and curved approach capability. MLS avionics system hardware to satisfy this need will be required in an estimated 4,300 aircraft.
- Regional and Commuter Aircraft — Will be heavy users of the MLS in the early and follow on years of the program. They will need to equip an estimated 2,600 aircraft with avionics systems hardware to provide them with a segmented approach capability.
- Corporate Aircraft — Will have a mix of avionics requirements for both segmented and up to curved approach capability. This is estimated at 100,000 aircraft.
- Charter Service Aircraft — Will require a mix of avionics for both segmented and up to curved approach capability. This is estimated at 250 aircraft.
- General Aviation Aircraft — This segment of the fleet will generally be equipped with basic avionics capability which will provide for DME, ARC and MLS straight in conventional approaches and segmented approaches. It is estimated that 287,000 aircraft will be equipped for these capabilities
- DOD Aircraft — The DOD has a large requirement for MLS avionics. It is estimated that more than 2,875 aircraft will be equipped with commercial MLS type avionics. More than 18,000 aircraft will be equipped with multi-mode receivers, military standard MLS/ILS receivers or tactical receivers.

INTERNATIONAL ASPECTS OF MLS

The ICAO effort to develop a new landing system has been conducted in parallel with the U.S. program. In 1972, ICAO invited interested countries to submit system proposals to satisfy the operational requirements. Proposals were submitted by five countries (Australia, Germany, France, U.K, and U.S.). In 1978, after an extended period of evaluation and operational demonstration, the MLS technique developed and proposed by the U.S. and Australia was adopted for international standardization. Since 1978, the ICAO program has been directed toward obtaining approval of Standards and Recommended Practices (SARPS). These standards for the angle and data functions were approved in April 1981, and now form a part of Annex 10 to the Convention on International Civil Aviation. In December 1982, the standards for the range functions (DME/P) were recommended for approval and will become a part of Annex 10 in November 1985.

Canada and the Developed Nations

The U.S. is not alone in the development of MLS Ground Stations. In Canada, the second largest world market, the Canadian Government is supporting indigenous development of MLS, with plans to enter production procurement in 1985. There are similarly funded development programs in the U.K., France, Japan, Australia and the USSR. These countries view the world market for MLS ground stations and avionics as a very attractive export opportunity. MLS has been adopted by NATO, and member countries are presently moving ahead with implementation programs. At the present time, there is an estimated requirement for 2,000 ground systems to meet international needs.

Third World

MLS provides greatly improved operational capability and performance over ILS and is particularly attractive for third world and developing countries because its implementation cost can be more accurately estimated than ILS. Siting, installation and flight inspection costs can be more accurately defined for MLS than for ILS. Often, ILS siting costs exceed equipment costs. MLS can be provided to meet specific schedules without delays that have been common to ILS establishment.

Worldwide Avionics Requirement

This is a market that must be accurately surveyed by industry and governments and will have a high sales potential during the next 15 years. This involves equipping new aircraft as well as retrofitting existing aircraft with MLS avionics. There are thousands of aircraft that will require equippage of MLS avionics to meet their needs. These will require a range of equipment configurations from the Basic Approach to the Segmented Approach capability and the air carrier and cargo heavy transport group will require the most sophisticated avionics for a Curved Approach capability.

ECONOMIC IMPACT

Implementation of MLS in the U.S. (1,250 FAA and 326 DOD ground systems plus a large number of nonfederal systems) plus equippage of scores of thousands of aircraft with associated avionics equipment will involve several billion dollars in expenditures. Each dollar spent will, in most cases, be spent again and again, thereby creating a tremendous economic impact throughout the U.S. in terms of new jobs and the sale of consumer goods to those workers. As to foreign sales, another market in the billion-dollar range appears as a potential for the sale of U.S. goods abroad. Accordingly, a formal, detailed Economic Impact Study is needed to correctly assess the overall impact of MLS.

WHY MLS SUMMARY

This chapter provides an explanation of the MLS system, both ground and airborne. The advantages of MLS were described in the early parts of the chapter followed by a discussion of the limitations of the existing ILS system. These two areas explain why MLS is required and give a preview of its operational benefits.

The equipment layout, functions and technical parameters of the MLS Ground Station were described. A compliment of text, figures and pictures were used to provide an overall understanding of the ground system concepts. To round out this understanding, much the same thing was done for the MLS operational capabilities. This section covered the technical aspects of the three approach capabilities, i.e., Basic, Segmented and Curved. This was followed by the types of avionics and the equipment configuration that is required to support these operational capabilities. Various MLS siting considerations were presented including equipment location, critica

ıreas, shadowing and extended coverage. Once ʍLS is installed, a need for maintenance and ›peration will exist. An overview was provided ›n the '80s Maintenance Program and how the nonitoring of the system will be accomplished.

An important element of this chapter is the ndustry perspective and the market potential as- ociated with this program. This was defined ›oth in terms of its application in the U.S. and ›n the international scene. In addition, a short ection was included on the Economic Impact ›f MLS as it appears to the U.S.

This material should provide the reader with an overall understanding of why MLS is needed as part of the NAS and for worldwide implementation. Some of the major features provided by MLS to support the growth of aviation are listed below:

- Reduced sensitivity to siting and environment.
- Continuous Angle and Range indication.
- Improved signal quality.
- Availability of 200 channels.
- Wider guidance coverage sectors.
- Basic system design and use of advanced technology.

Chapter 3

MLS AND THE USER

Contents

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MLS AND THE USER

INTRODUCTION

Compared to ILS, MLS is a vast improvement in operational capability and performance. It presents a significant challenge for FAA and the users to implement and utilize its enhanced features in the most effective manner possible. It is important that all airspace users understand the capabilities of MLS and plan for its application at this point in the program because MLS is a new system with its own diverse capabilities, not a modification of ILS.

The earlier MLS's broad capabilities and operational features are utilized, the earlier its benefits will be clearly measurable in both time and dollars.

This chapter will examine the concerns, benefits and roles regarding users. The timing and planning of various user groups in their move toward acceptance and operation of MLS as their primary precision landing system will also be examined. The users that will be discussed are: Air Carriers, Military, General Aviation, and Airport and Heliport Operators.

AIR CARRIERS

The implementation of MLS by the air carriers will provide them with a wide-range of operational flexibility. Air carriers are the scheduled, regional, supplemented and commuter carriers. The operational flexibility provided by MLS will translate directly into efficiency and cost savings to the air carriers. Unfortunately, some of these advantages — especially for the long haul, heavy jet aircraft — will not be available to them until MLS is installed at most or all of the airports where they operate because of their equippage delay.

Concerns

The airlines have a number of valid concerns regarding MLS implementation, mostly operational and financial concerns that will exist early in the program. Some of these concerns are:

- Initially, there will be a duplication of precision approach service at certain locations where MLS is installed on ILS equipped runways. When the additional MLS service does not improve the minima, or provide additional approach capability that will reduce costs, it is not operationally advantageous to the airlines.
- The air carriers are concerned about benefits which will accure only after most airports where they operate have been equipped with MLS. Again, in these cases, they cannot justify early changeover to MLS on a cost/benefit analysis.
- Avionics is not now available to support full low weather minima operations, and avionics manufacturers are not prepared to complete final designs until ARINC Specification 727 is updated.
- MLS avionics installation in air carrier aircraft will be very expensive both in terms of the capital expenditures for hardware and the cost of installation, certification, and aircraft downtime.
- The MLS Ground Stations must have the same level of integrity as current ILS stations to ensure continued CAT II and III operations.
- The additional parameters available with MLS will provide for significant improvements in system performance and enhanced capabilities such as runway distance-to-go, deceleration monitoring, etc. However, the integrity of these parameters will determine to what extent these features can be incorporated into the design of future systems.
- The air carriers are concerned with the airborne antenna locations as to the types of aircraft in use. Some of the issues to be resolved are:

1. Antenna Location: Single or Dual requirement

2. Antenna Switching Requirement: When to switch; affect on Control Laws
3. Transition from Front Azimuth to Back Azimuth on a go-around

Some of the concerns are those that are common to any new system; most have been systematically studied and will be fully investigated. Answers will be provided prior to air carrier MLS implementation.

Benefits

Activity is underway to demonstrate the benefits of MLS to the air carriers. For example, emphasis was directed at the Burbank Airport concerning the terrain, smog and noise problems which exist at that location. The knowledge gained at Burbank may provide TERPS data and cockpit workload data which could relate to certification and crew interface problems.

Work has begun in the area of developing the control laws and the analysis of the possible MLS benefits to air carriers. For example, simulation results to date indicate that MLS will have much lower signal noise levels relative to ILS with the most marked difference existing in the case of lateral guidance. As a result, the landing simulation indicates a smoother approach and landing with MLS than currently possible with ILS.

At present the benefit analysis is not complete. A benefit study will attempt to identify benefits to air carriers in terms of resolving or improving the typical problems which plague airport operations. A sample airline will be selected and a description of current operations prepared. The analysis will then determine how MLS would improve operations. The resulting benefits will be confirmed by canvassing industry associations, airline and airport operators, and FAA regional offices by questionnaires, telephone conferences and visits.

Some of the MLS benefits to the air carrier operators are:

- Segmented approach capability
- Curved approach capability
- Lower service minimums
- Precision departures/missed approach
- Reduced operational delay
- Increased airport capacity
- Favorable operational configuration
- Aid in noise abatement
- Avionics compatible with flight control systems and displays
- Cost savings

Role

The role of the various air carrier users will be different both in terms of their approach to MLS and their implementation strategies. The hub/spoke implementation concept will provide early incentive to the commuter and feeder operators to install MLS avionics. The commuters should be quick to equip with MLS avionics when they can improve their service and cut costs.

Long haul and regional airlines will be driven by the same forces as the commuter operators. However, a separate circumstance will be involved in their planning. The air carrier group will generally be operating into areas which already have established ILS service. Therefore, their need to equip with MLS avionics will come after considerable MLS ground equipment has been installed. Their position is not to install MLS equipment on runways that now have ILS except for special cases such as noise abatement demonstrations, etc. The installation of MLS avionics in air carrier heavy jet aircraft will be expensive but they should benefit from a quick transition from ILS to MLS once a majority of the systems are in place nationally, and as may be applicable, internationally.

Equipment Acquisition Planning

The air carriers must start now to plan for the types of MLS equipment and operational equipment configuration they will require to continue operations when ILS is phased out where they operate. Development work is currently under way, however, MLS avionics is not currently available to support full low weather minima operations by air carriers. Manufacturers are not prepared to design and produce MLS receivers until ARINC Specification 727 is updated.

MLS is viewed as serving a dual role of providing precision landing service and also being a terminal area navigation sensor. A variety of displays and integration methods are possible depending on whether a cockpit instrumentation is electronic or electro-mechanical and depending on the need for raw data displays to monitor autopilot/flight director operations during instrument approaches. Two types of computers are contemplated: a flight management computer (FMC), and a flight control computer (FCC). The FMC will fly the approach procedure up to capture of the signal on the extended runway centerline; the FCC will fly the final approach path to touchdown and through rollout.

Training

Aircrew training for MLS should not differ much from ILS. The type of avionics capability (basic, segmented or curved approach) will determine the type and level of training required in the aircraft or simulator. The cockpit configuration will remain essentially the same so there will be minimal need for additional familiarization with the cockpit layout. Air carrier operators who handle the repair and calibration of avionics themselves will have to train their technical work force to maintain the MLS avionics. All-in-all, the training requirements should not be substantial. FAA operations and maintenance inspectors will also have to be MLS trained and available at the appropriate time to provide air crew and repair station certification in accordance with air carrier planning.

Acceptance

Acceptance of MLS by the air carriers is something that will come with their use of and experience with the system. At present, programs are underway to provide pilots an opportunity to gain hands-on experience with the MLS. One such project is the "Richmond Demonstration Project". Another example is the use of commercial pilots in the Air Force Reserve who are taking part in the FAA/USAF Flight Test Program. As more MLS ground equipment becomes available, more and more air carrier personnel will have an opportunity to experience MLS operations.

The design features of MLS can be directly translated into operational and cost advantages over ILS. These advantages can in turn be related to: (1) benefits to FAA as the operator of the system, and (2) benefits to air carrier operators and users of the system. As the implementation of MLS proceeds, wide spread acceptance of MLS is expected from pilots and the air carriers.

MILITARY

The Department of Defense and its military services will be the single largest user of MLS in the U.S. and perhaps the world. DOD has been involved with DOT/FAA and NASA in the development of MLS since its outset. A DOD MLS Implementation Plan outlines the joint service MLS planning objectives and acquisition strategies for implementing the system. International and domestic civil plans to transition from ILS to MLS have a significant impact on DOD landing system requirements. Large numbers of DOD aircraft have a requirement for interoperability with the standard civil landing system. Also, a large proportion of DOD's total force is home based at joint-use or civil airfields.

Concerns

DOD has worldwide deployment commitments. At present, for the sake of interoperability, they must maintain three precision landing systems in addition to MLS: Precision Approach Radar (PAR), Marine Remote Area Approach and Landing System (MRAALS), and ILS. With the implementation of MLS, DOD should be able to standardize to one system, MLS, by the year 2000. There are several benefits as a result of military MLS application. There are also some concerns. These have been and will continue to be addressed and monitored so as

to successfully implement the DOD MLS program. Some of the areas of concern are:

- Precision Approach Radar (PAR) has been retained in the inventory over the years to provide a transportable precision landing capability which is interoperable among the services and with U.S. allies. PAR is, however, manpower intensive and is not well suited to fulfill needs forward of well established operating bases. MLS will eventually satisfy the PAR requirement.

- The Navy and Marine Corps have specialized requirements. Carrier landing systems have had to be developed. Naval aircraft have generally been optimized for shipboard operation and depend on PAR for recovery on land. This has offered a limited flexibility in recovering at civil airfields in bad weather and has required PAR equipments at DOD airfields. The addition of MLS avionics should satisfy this concern.

- All of the services have a need for a precision landing capability forward of full service airfields for which they now expend transportation resources to deploy a PAR. The Marine Remote Area Approach and Landing System (MRAALS) is suitable for forward area operations. The Marine Corps is limited, however, by the number of aircraft that are equipped with compatible receivers. If Marine Corps aircraft were equipped to interpret MRAALS only, they would lack the capability to recover at ILS, or MLS, equipped airfields. Therefore, the Navy is pursuing the Multi-Mode Receiver (MMR) program to overcome interoperability limitations. MMR will interpret MRAALS, ILS, MLS, and the Instrument Carrier Landing System (ICLS).

- To provide interoperability with civil and allied military aircraft, all DOD ground MLS equipment shall be equipped with DME meeting ICAO requirements. The DOD Global Positioning System (GPS) Joint Program Office has concurred that GPS does not satisfy precision approach requirements as specified by ICAO. The feasibility of using GPS in lieu of the MLS DME-P subsystem shall be investigated.

Benefits

The benefits that were identified in the Air Carrier section of this chapter also apply to the military. Therefore, this section will only discuss the additional benefits which MLS will provide as a result of military application.

The establishment of a single precision landing system will simplify logistic problems, preserve interoperability with the international civil sector, within the services, and with U.S. allies, all at significant cost savings.

DOD will take advantage of available commercial avionics through avionics procurement for Air Force cargo and transport aircraft as necessary to acquire an early tactical capability. Also, Army instrument training aircraft are planned for MLS commercial avionics equippage to coincide with Army ground equipment installations.

The Microwave Digital Design Technology and the modular configuration are well suited to the development of a tactical/transportable MLS ground system (estimated weight 500 lbs). Its development, test, and acquisition have been authorized. One version will be used to meet Air Force/Army needs for off-airfield use. The most sophisticated version will provide the Air Force with Category II service in both directions on the main runway of a bare base plus replace PAR in that role by the year 2000. Maximum commonality among all versions is required. The MLS design features will provide the following benefits to the military.

- Provide for smaller avionics
- Fulfill the tactical requirements of the military
- Support rotorcraft flight profiles

Role

The role of the military services in MLS avionics will remain much the same as for the MLS ground system acquisition. The Air Force will provide for centralized procurement of commercial avionics for the DOD per interservice funding agreements. The Navy will develop the MMR

and provide for procurement of DOD requirements for the MMR. The Air Force will accomplish the R&D for the military standard (MIL STD) MLS/ILS receiver, and if this effort is approved, provide for DOD procurement of this receiver. Each service will fund its own aircraft integration requirements.

It is not anticipated that a Joint Program Office will be established prior to the approval of a MIL STD MLS/ILS receiver. However, it is envisioned that a full-time Army representative(s) will reside at the Air Force Program Office to participate in Tactical MLS ground equipment and commercial avionics acquisition efforts.

The Air Force is developing a Tri-Service Program Management Plan to conduct MLS acquisition efforts. MMR status will be reported in the plan; however, the Navy/Marine Corps will conduct the MMR program. Each service will coordinate its detailed MLS ground equipment/avionics installation schedules with the other services to ensure interoperability requirements are continually met. The Air Force will be responsible for the preparation of the necessary interservice and interagency Memoranda of Agreement.

Under the DOD program, commercial MLS airborne receivers may be acquired to meet near term Air Force and Army requirements for transport aircraft. Specific OSD approval is required prior to initiation of any new military avionics development program. Duplication of effort or proliferation of avionics equipment must be avoided if DOD is to be able to afford the MLS program.

The U.S. will comply with the NATO Conference of National Armament Directors' plan for transitioning from PAR to MLS to maintain landing system interoperability at NATO main operating bases. The U.S. will also work with other various NATO bodies to standardize landing systems at other than main operating bases. The U.S. will subscribe only to NATO MLS ground system standardization requirements which call for interoperability with the ICAO standard MLS.

Equipment Acquisition Planning

MLS is to replace PAR and ILS for interservice precision landing system interoperability requirements, and operation with allies, per the JCS Master Navigation Plan and NATO agreements.

The DOD program is developed around the following planning assumptions:

- Services will interoperate with each other with PAR until the late 1990s.
- Services will interoperate with NATO allies with PAR until 1998 as agreed to in NATO PAR/ILS Transition Plans.
- Services will interoperate with the international and domestic civil sectors in accordance with ICAO plans to transition from ILS to MLS by 1995, and in accordance with the planning dates in the NASP and the FRP.
- The Navy/Marine Corps will equip its aircraft with MMR during the 1988-1998 time frame. Its aircraft will be interoperable with the civil sector, the Air Force, and the Army regardless of the state of ILS/MLS transition.
- The Marine Corps will use MRAALS for forward area V/STOL operations. Fixed wing Air Force/Army aircraft will recover at Marine Corps expeditionary airfields using the PAR capability inherent in the Marine Corps air traffic control and landing system (MATCALS). Air Force aircraft, mainly rescue and special operations helicopters, needing MRAALS capability will be equipped with MMR. The Marine Corps will investigate replacement of MRAALS with a version of the Tactical MLS as MRAALS equipments are retired.
- Air Force aircraft will be equipped with ILS and MLS capabilities to interoperate with the civil sector throughout the transition.
- Army aircraft needing a tactical precision landing capability will be equipped with an MLS capability. Tactical MLS equipment developments will address Army needs. Army aircraft which are currently ILS equipped will retain that capability until MLS is generally implemented.

- DOD MLS Avionics (Number of aircraft):

	Commercial	MMR	MIL STD MLS/ILS	TOTAL
Air Force	2,800	TBD*	TBD*	8,300
Army	75+	TBD	TBD	4,500
Navy/Marine Corps	None planned	6,100	0	6,100
DOD	2,875+	TBD	TBD	18,900

*The total number of Air Force aircraft for MMR or MIL STD MLS/ILS is approximately 5,500 and is to be determined (TBD) later.

- As the lead service for MLS, the Air Force will prepare alternative strategies for Tri-Service evaluation, and will coordinate the recommended alternative with the Army and Navy/Marine Corps.

Figure 3-1 provides the DOD Microwave Landing System Program Master Schedule, and Figure 3-2 provides the Procurement Profile.

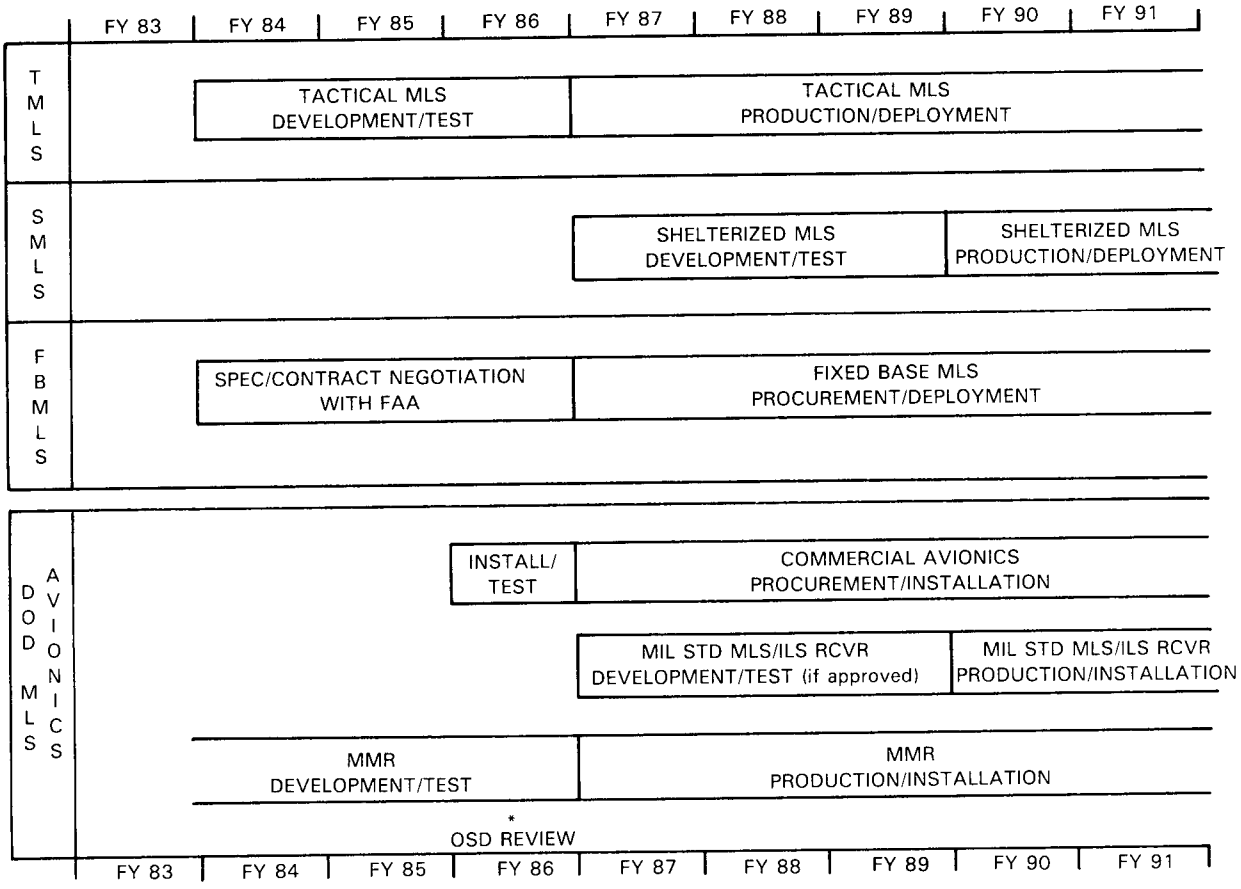

Figure 3-1: DOD Microwave Landing System Program Master Schedule

	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	Total
RMY																	
round Equipment																	
TMLS					11	11	16	16	16	16	16	15	7				124
FBMLS			2		11	15											28
vionics																	
Commercial/MIL STD/MMR				75		(Qtys from 87-98 TBD)											4500
IR FORCE																	
round Equipment																	
TMLS					23	15	30	25	25	10							128
SMLS								15	25	25	25						90
FBMLS					3	6	8	25	25	25	25	25	25	24			191
.vionics																	
Commercial					117	130	282	300	300	300	300	300	300	300	171		2800
MIL STD/MMR								300	500	800	800	800	800	800	700		5500
IAVY/MARINE CORPS																	
iround Equipment FBMLS				10	10	10	10	10	10	10	10	10	10	7			107
\vionics																	
MMR					400	400	700	900	1200	1200	800	400	100				6100

Figure 3-2: DOD Procurement Profile

Training

The DOD will have a large training requirement resulting from its transition to MLS. The training requirements extend to all areas of MLS which include operations, maintenance, flight inspection, tactical deployment, procedure, etc. Planning for MLS training is underway and much of the training will be done within DOD. However, DOD will evaluate the FAA Academy MLS Training Program as an alternate to service-organic training programs. A similar effort is anticipated in the Flight Inspection area, where the Air Force and FAA will work together to establish a Flight Inspection capability.

The MLS training programs for the military services will continue to evolve over the life of their implementation program. Much of the training will be similar to the training required on the civil side, except of course, the tactical training requirement.

Operational Flexibility

MLS will provide DOD with an additional operational flexibility through the implementation of the Tactical MLS (TMLS) program.

Tactical MLS Program—The Tactical MLS program draws from prior military tactical MLS and civil MLS developments to obtain an off-airfield landing capability for operations in adverse weather. This capability supports initial deployment of ground forces, forward area resupply, medical evacuation, and special operations missions. Within the Air Force, the initial TMLS and complement of MLS equipped C-130s will provide the Military Airlift Command (MAC) an initial operating capability in

FY 88. It is envisioned that the basic TMLS will weigh approximately 500 pounds, be assembled within 30 minutes, operate up to eight hours on batteries (two hours if used continuously), and require minimum field maintenance. In addition to MAC, the Air Force Communications Command, associated Air National Guard units, and Army company equivalents will also acquire TMLS.

DOD Avionics Planning—DOD avionics planning is comprised of several efforts:

1. Commercial Avionics
2. The Multi-Mode Receiver (MMR)
3. A potential Military Standard (MIL STD) MLS/ILS receiver effort

The first two receivers have been discussed. The following will only address the third, because of its applicability to the tactical program. The objectives of the MLS receiver effort are:

1. Develop a MIL STD MLS/ILS receiver with form and fit characteristics that will allow it to replace existing fighter aircraft VOR/ILS equipment of varied sizes.

2. Integrate this receiver with aircraft system to:

- Achieve a Category II landing capabilit in a single seat fighter.
- Eliminate the need for separate DMI avionics.
- Eliminate the need for MLS-uniqu computational capability needed for seg mented approach and offset landings i.e., integrate with existing on boar computers where possible.

Civil sector and NATO plans are for a genera conversion from ILS/PAR to MLS by the lat 1990s. The conversion will require a considerabl DOD investment to remain compatible. A sig nificant increase in combat capability is realize with the tactical equipment acquisitions. Servic funding from FY 84 to FY 87 focus on acquirin needed military capabilities independent of civ sector conversion. If civil sector plans proce as outlined earlier, MLS avionics efforts mus proceed quickly in the 1990s. This plan provide a framework for implementing MLS withi DOD. It will be supplemented by a Tri-Servic DOD MLS Program Management Plan an service-unique planning documents.

GENERAL AVIATION

The General Aviation (GA) segment of the aviation community has the greatest numbers and types of civil aircraft in the U.S.; over 200,000 aircraft and the majority are instrument equipped. This part of the aviation community will attain significant benefits from MLS and can realize these benefits early in the program if they are MLS equipped.

Concerns

The GA community is not without its concerns regarding the MLS program. Most deal with issues and areas that are similar to the concerns of other segments of the aviation industry. Items of particular concern to GA are:

- Affordable MLS avionics for GA aircraft.
- Supplemental Type Certificates for ML avionics installation for a large variety of GA aircraft.
- Transition period when GA must conten with ILS and MLS equippage.
- Amortization of ILS avionics presently in stalled in GA aircraft.
- Firm MLS site locations to assist GA wit realistic MLS equipment acquisition planning

As the new Federal systems come on line, GA pilots will have an opportunity to fly and ex perience MLS in the real world environment. I addition, an MLS demonstration program is be ing provided at Richmond, Virginia, and state owned facilities are available for such use i Michigan.

Benefits

From the outset of the MLS program, FAA plans were to install MLSs at airports and heliports and on runways that are not now ILS equipped. Installed in the hub/spoke concept, the system will allow GA pilots with MLS equipped aircraft to have an all-weather capability at airports at or near their base and with all-weather service capability to the surrounding area.

The GA operators will have the full range of avionics capability available to them, i.e.; basic, segmented and curved approach. However, in most cases GA operators will probably opt for basic MLS avionics and the resultant basic approach capabilities. This will provide much the same kind of service that is presently available with ILS. Some of the GA fleet will be equipped with a segmented approach capability; a small number with the curved approach capability.

The addition of MLS at airports and on runways not now ILS equipped will provide long term cost savings to GA operators and will provide them greater operational capabilities. MLS, because of its relatively low cost and ease of installation and maintenance, may appear at a number of locations not funded by the Federal government, but which are clearly beneficial and advantageous to GA operators.

Low cost MLS avionics for the basic configuration are not presently on the market, but should be in the near future. It is estimated that MLS receivers for GA aircraft will be available in a price range from $1,000 to $2,500.

Training

The operational requirements using MLS for Category I and II approaches and landings are the same as for ILS. There are four considerations in conducting such operations: pilot proficiency, aircraft evaluation, equipment requirements, and maintenance. Training requirements to support these considerations will be required in GA as they are in the other sectors of aviation.

The acceptance of MLS by the GA community will depend on the benefits and operational advantages it provides them. To make this assessment, they will need to be exposed to and use operational facilities. At present such facilities exist in Alaska, Michigan, Texas, and Virginia.

AIRPORT AND HELIPORT OPERATORS

The airport and heliport operators have a different perspective from the three users previously discussed. The Airport operators view is one of how can MLS improve operations, increase capacity, abate noise, enhance safety, etc., at a particular facility. For the operator, there is a good number of possibilities to improve each of these areas through the implementation of MLS. Because of its flexibility and siting adaptability, MLS should increase runway utilization through the establishment of precision approaches and departures, and guidance at locations which was not possible with ILS.

Concerns

The operators have concerns in two areas of MLS implementation:

1. The FAA Federal F&E MLS establishment program.

   - The operators need to know when they will receive MLS equipment under this program and the specific site locations.
   - When specific installation times and locations are known the operators can effectively plan for additional MLS requirements. To date, 172 sites have been identified.

2. The Airport Improvement Program (AIP) and the Nonfederal Program.

   - At present F&E and AIP qualifying standards for MLS are the same. The airport and heliport operators would

like to see modifications to the criteria to allow greater flexibility in obtaining AIP funds to purchase MLS ground equipment.

- The operators are concerned with FAA takeover policy for nonfederal facilities. Presently, if the MLS equipment is not identical in every detail it will not qualify for FAA takeover at a later date.
- Operators are awaiting fixed procurement and operation costs of MLS nonfederal ground stations to make accurate and realistic estimates for planning nonfederal acquisitions. Several locations have already installed and commissioned nonfederal systems. Cost data, including acquisition, operations and logistics on these systems should be available within the next few years.

The nonfederal program can be used by operators to obtain MLS service to fulfill immediate landing system requirements. To encourage the nonfederal program, FAA is considering criteria so that these facilities may receive AIP funding and eventually be taken over by FAA for operations and maintenance.

Benefits

Operators will benefit from the installation of MLS at their facilities, including an increase in airport capacity. Some examples are:

- Establishment and use of MLS on short runways and at heliports.
- Availability of higher angle glide paths to accommodate STOL aircraft and helicopters.
- The use of MLS on converging runways.
- At some airport locations, MLS will provide operational advantages where there is a conflict in available airspace, converging IFR approaches, and triple parallel approaches.
- The back course of an MLS can provide precision guidance and maintain more efficient operations during departures and missed approaches.
- Because of the low cost, ease of installation and maintenance of MLS, operators may elect to purchase and install MLS at sites that do not qualify for Federal establishment or funding.
- Early establishment of MLS through the AIP or nonfederal programs.
- Use of offset MLS approaches by helicopters for approaches to helipads on the airport.

MLS is in no way a substitute for "concrete" in relation to capacity. However, MLS can help to improve the utilization of existing runways and heliports and thereby lead to increased airport capacity.

Role

The operators play an important role in the MLS ground station installation, whether it is an F&E, AIP or Nonfederal Program. Other events in which they are involved include:

- Acquisition or provision of land to establish MLS.
- Interface with facility prime power sources.
- Planning for construction activities.
- Coordination with FAA and Contractors
- Site selection process.
- Site preparation and removal of obstacles on airports and heliports, if required.
- MLS acquisition, if AIP funded or nonfederal.

Implementation Planning

The implementation planning on the part of the operators will follow the FAA MLS implementation plan to a large degree. Where F&E systems are planned, it will follow the FAA program exactly. An exception might be when a Federal system establishment is too far in the future to meet a current need at a particular airport. However, the individual airport or heliport implementation will relate directly to the F&E planning for its basic guidance. When F&E and AIP Programs are not involved, the operator can proceed more independently with his planning for the establishment of nonfederal facilities. There is, however, a requirement for FAA coordination, Flight Inspection, and Facility Certification before an MLS is placed in service.

MLS AND THE USER SUMMARY

Each user group was assessed in terms of its concerns, benefits and the role it will play in the overall implementation scenario. The assessment reveals that user interests are quite different.

Air Carriers

The air carriers are the primary transporters of the American flying public. They are the operators of scheduled, regional, supplemental and commuter aircraft that have modern and sophisticated avionics equipment on board to provide for efficient and safe flight operations. MLS will have a definite impact on their operations and planning.

Military

The Department of Defense as a user of the system has a dual role. DOD is involved in the development and implementation of the system and is the world's largest user and operator. Thus, the military role extends beyond the program interests of the Air Carriers and the others since it has U.S. national defense interests and worldwide deployment commitments. DOD is looking at MLS to replace ILS as the standard civil landing system per the National Airspace System Plan (NASP), the Federal Radio Navigation Plan (FRP), the Joint Chiefs of Staff (JCS) Master Navigation Plan, and for ICAO international standardization.

The military has a responsibility to develop a tactical MLS to meet its national defense commitments. In addition, all the MLS ground systems being procured by the military must be interoperable with the three services as well as the civil systems being provided as the international standard. Furthermore, DOD's operational role is large and complex and must fulfill its commitments to NATO and maintain landing system interoperability at all of NATO's main operating bases.

The operation of DOD aircraft in the U.S. will be at joint-use or civil airfields. Its operations at these airports must be compatible with the requirements of the civil system. Because of this, DOD plays a major role in supporting the testing and evaluation of procedures and participating in flight test programs in direct support of the development of MLS operational requirements.

General Aviation

The GA community represents the largest number of civil aircraft owners. As a group, GA represents owners who operate from grass strips to the most sophisticated airports and terminal areas in the U.S. Many of the GA pilots have and require instrument capability for precision approaches and landings. The implementation of MLS will provide them with improved services at a greater number of airport, heliport, and runway locations. The hub/spoke concept will give them a much greater operational flexibility in areas where they most frequently fly. The transition period is critical to their planning in terms of:

- When to equip with MLS avionics.
- Length of time when both MLS and ILS avionics will be required.
- Development of networks in areas where they frequently fly.

At present, GA is concerned about the price and availability of low cost MLS receivers. GA is also in a period where it is important to the individual pilot to have an opportunity to use and experience MLS as a precision landing system.

Airport and Heliport Operators

The airport and heliport operator is a user of MLS in a different sense than the previous users. The operator is concerned with: How can MLS improve operations? Will the addition of MLS increase runway and heliport utilization and capacity? MLS has the capability to enhance capacity and to increase utilization where it is established on short runways or on those requiring higher angle glide paths to clear obstacles in the approach zone. The establishment of back

courses will certainly increase operational efficiency for missed approach and instrument departures.

The availability of MLS under AIP or the Nonfederal Programs will increase the potential for precision landing system capability at locations that may not qualify under the F&E Program.

For those facilities that qualify, but are no scheduled for implementation until much later AIP may allow operators to commission ML! at a much earlier date. The individual air port/heliport MLS planning is closely associate with FAA's MLS Implementation Plan. Thus the operators play an important role in the over all establishment of the MLS ground station through a coordinated role with FAA.

Chapter 4

MLS PROGRAM OFFICE

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INTRODUCTION

The management and acquisition of major systems in the FAA follow OMB Circular A-109 and FAA Order 1810.1. These documents provide budgetary consideration and direction for the management process involving a major system acquisition. Program accountability rests with the Program Manager and his office. This chapter explains how the MLS Program Office functions. It also provides information about the planning process, management techniques, and implementation scheduling and strategy.

MANAGEMENT APPROACH

The MLS Program Office was established by the FAA Administrator in accordance with FAA policies and procedures for the acquisition of a major system. The office is headed by a Program Manager who is personally accountable to the Administrator for the overall management of the MLS program. The staff of the Program Office is small and consists of highly specialized technical experts skilled in major disciplines critical to the program. The overall scope and responsibility of this office and the Program Manager reaches out in a matrix mode and directly interfaces with all FAA offices and organizations involved in the MLS process and its implementation. A definition of the matrix management concepts will be discussed later in this chapter.

Management Process

The MLS Program Office serves as the focal point for the FAA in providing program control, monitoring and guidance.

The role of the Program Manager and the Program Office on a Major System Acquisition is to provide centralized management authority over all aspects of the program. Therefore, the role of the MLS Program Office is to integrate and coordinate, to manage, and to direct the development, production, and implementation of a system meeting predefined goals of performance, schedule and cost. The Program Office thus has the responsibility for ensuring that the MLS program proceeds through its life cycle. The Program Office relies on others to do most of the work, but it also exercises control and coordination of the work so that no one aspect of the program dominates others to the detriment of the overall program. To be effective, the MLS Program Office must function as follows:

- Control and coordinate all work efforts for the total program.
- Rely on others outside the Program Office to do the majority of the work.
- Establish a staff which includes representatives from the requirements/user organizations.
- The authority and responsibility of the Program Office must be defined and made available to all levels of management in all supporting organizations.
- The overall mission of the Program Office must be documented and clearly defined in appropriate directives, orders and handbooks.

Management Staff

The Program Office is staffed with skilled professionals who have specialized expertise in critical areas of the program. These professionals not only provide a firsthand working relationship with major support organizations, but they also provide expert technical support to the Program Manager on a day-to-day basis. They are assigned to the Program Office by their parent organization for fixed periods of time.

The MLS Program Office keeps top FAA management informed on all significant events

of the MLS Program, including verbal communication on significant daily events and "Alert" or other written communications on important matters that need to be formally documented. Formal briefings and reviews are also provided in accordance with agency directives. An example of such a briefing is the Quarterly MLS Program Review for the FAA Administrator and other top level officials of FAA and DOT.

MLS Documentation

There is a continuing need to develop and update all documentation required for the effective management, monitoring and control of the MLS Program. The Program Office must ensure that all such documentation is provided, updated and available on a timely basis. Although much of this documentation is the responsibility of other organizations, certain key directives involving program policy and implementation are the direct responsibility of the Program Office. Two such documents are the MLS Program Master Plan and the MLS System Implementation Plan. The former provides MLS program policy guidance and direction while the latter provides the planning and strategy for MLS implementation. These documents require periodic updates. Other publications such as "Getting Ready for MLS" and this Indoctrination Handbook are also products of the Program Office. These documents are used to keep FAA, user groups, and the public informed and knowledgeable of the significance, complexity, magnitude, and overall value and importance of the MLS program.

Management Decisions

MLS management decisions must take into account the needs and desires of various user groups [Air Transport Association (ATA), Aircraft Owners and Pilots Association (AOPA), Air Line Pilots Association (ALPA), General Aviation Manufactures Association (GAMA), National Business Aircraft Association (NBAA) and Regional Airline Association (RAA), etc.] when such decisions affect their operational, economic or public service interests. Therefore, the Program Office must work closely to bring these groups together for coordinating and solidifying a common position on planning, implementation and MLS site selection.

Many organizational elements within FAA headquarters play an important role in the implementation of the MLS program. Examples are:

- The Navigation and Landing Division, APM-400, has the Technical responsibility for the contract phases of the MLS hardware systems. This Office also has the responsibility for all Engineering and Technical requirements associated with the implementation of the MLS ground systems. All matters associated with the acquisition of the MLS ground equipment is monitored by and coordinated with the Program Office.
- The Program Management Division, APR-100, of the Office of the Associate Administrator for Aviation Standards, has the responsibility for the identification, coordination and selection of MLS candidate sites. This effort, which is performed in conjunction with the budgetary process on a fiscal year (FY) basis, leads to the selection of sites on an annual basis throughout the life of the program. It involves a highly coordinated effort which includes inputs from the user groups, FAA Regions, APM-400 and the Program Office. The process is very complex and difficult in the early years of the program due to all interested groups wanting early installation and commissioning of Microwave Landing Systems to meet their particular needs. The Associate Administrator for Aviation Standards is responsible for ensuring that site selection is made equitably and in accordance with policy.
- The Air Traffic Procedures Division, Terminal Procedure Branch, ATO-320, is responsible for the development, preparation, coordination and availability of appropriate MLS ATC procedures to support the scheduled implementation of the MLS Program. The Program Office maintains a continual working relationship and direct interface with ATO-320 to ensure that all schedules and target dates are identified, that adequate lead time is established and that all actions are properly coordinated.

Management Communication

As the MLS Program moves into the implementation phase it is essential that viable communications be established and maintained with the field organizations. The Program Office uses several methods to ensure that a communications breakdown does not occur. For example, in 1984, all regions provided representatives to serve as Regional Associate Program Managers. These individuals serve as the focal point for MLS in the regions much the same as the Program Manager does for the agency. In addition, other individuals were identified to be focal points in other field organizations, the regions, and in headquarters. Some of these are: Aviation Standards National Field Office (AVN); Technical Center (ACT); FAA Depot (AAC). Furthermore, the following activities and events support this communication link:

- The Program Office conducts an annual Associate Program Managers conference to ensure that all key MLS players are fully informed about the complete program.
- The Program Manager and individuals on his staff visit each region on an annual basis to brief the Regional Directors and their MLS Management Teams. These visits inform the director about current plans, program status and specific activities that relate to that region's MLS Program.
- Regional personnel are encouraged, when possible, to attend scheduled monthly MLS implementation working group meetings. This is usually done when they are in Washington on other business. Copies of the minutes of these meetings are made available to all Field Focal Point Personnel following each meeting.
- A bimonthly MLS Program Newsletter is prepared and distributed by the MLS Program Office for all interested parties both within and outside FAA.
- Articles on MLS are prepared and submitted by the Program Office for inclusion in the FAA *World* and "Intercom."
- Copies of all MLS documentation available to the Program Office are sent to MLS Focal Point Personnel and Regional Associate Program Managers. Phone communication is encouraged between these people and the Program Staff to accelerate communications and for the timely and efficient exchange of information.

MATRIX MANAGEMENT

The FAA has chosen to implement major programs through matrix management. This approach provides the MLS Program Manager and his office with the necessary skills and expertise to execute the program without disrupting existing organizations. While the matrix management concept includes certain inherent characteristics peculiar to managing a major program, it is extremely efficient since existing organizations serve as a pool from which the program may draw needed resources. Accordingly, when the Program Manager no longer needs a particular resource, that resource is returned to the pool for use on other programs and for the functional mission of the parent organization.

Matrix management principles are usually applied to major projects which involve advanced technology, are highly complex, and require a specific time to complete, typically five to ten years. The MLS Program qualifies as a matrix-managed project. The Program Manager and his office must be effective in obtaining the desired program results through use of line staff and organizations in support of the program. The matrix organization is one which is responsible for performance and planning, scheduling, budgeting, resourcing, and task monitoring. The Program Manager is responsible to top management for program execution within schedules and cost. The Program Office provides liaison and channels of communications up and down the management chain. It is also responsible for assigning tasks to traditional line organizations, often involving their best people and most valued resources. These tasks are assigned through program directives and other applicable written or verbal means.

User Influence

The establishment of the MLS Program Office in a matrix mode has presented a particular challenge. For example, while this program has a number of functions that are common to all programs such as organization, management, planning and project definition, the MLS Program is unique in terms of the large number of internal FAA functional organizations which have significant program involvement. Additionally, there is significant interest for and involvement in the MLS Program by organizations outside the FAA. They include user groups such as AAAE, AOCI, AOPA, ALPA, APA, ATA, GAMA, HAI, NASO, NBAA and RAA and other segments of the aviation industry. This program also involves DOD, NASA and international organizations such as ICAO that dictate variations in Program Office functional requirements.

The management and operation of the MLS Program is influenced by the composition and role of the Program Office in relation to the utilization of the functional organizations' resources in a supporting role. This relationship is critical to the proper balance and utilization of resources and must be monitored carefully by the Program Office. In general, the MLS Program Office provides the management and oversight function and the functional organization completes the various activities that fall within their areas of expertise. These activities are performed as major tasks under the auspices and authority of Program Directives.

Internal Support

The Program Office must ensure that the following series of items receive the full endorsement and support of top management:

- Establish a Program Manager's Charter and a Program Office.
- Provide documentation for program definition.
- Provide planning documentation.
- Establish the matrix organization.
- Provide Program Directives.
- Establish a system for program management, monitoring and control.
- Provide a staffing plan for assignment of personnel from functional organizations to the Program Office for specific tasks.
- Provide a management information system.
- Provide a system for the monitoring and control of schedules and costs.

For the MLS Program Office is to be effective, the functional managers must support the matrix concept and ensure that the functional organization is responsive to the Program Office in accomplishing each of the above items that fall within their jurisdiction. The role of the MLS Program Office is one of managing the overall program through direction, interface, communications and guidance to and participation with all entities who share a part in the overall successful completion of the MLS Program. The Program Office serves as the focal point of all activities and is accountable to top level FAA management to successfully complete the overall program within predetermined schedules and costs.

In structuring the matrix organization, it is necessary to have the functional organizations provide personnel support both in terms of utilizing that support within their organization and at other times assigning personnel to the Program Office on a temporary basis. The former type of support is more readily attainable than the latter. Appropriate FAA directives are necessary to communicate this requirement to all functional levels.

Program Office Authority

Maximum effectiveness in program management requires that the authority and responsibilities of the MLS Program Office and the functional organizations be clearly defined. Traditionally, the Program Office is given responsibility for the technical programs while the functional organization has responsibility for all tasks specifically assigned. Problems over authority arise if and when both elements perceive the same responsibility. This may be

avoided if it is clear that the Program Office has authority over all aspects of the MLS Program and the functional manager has only the authority defined by the Program Office in a Program Directive that is agreed to by both parties. A sample of an MLS Program Directive is provided in the Appendices.

Work Environment

Certain internal needs of the Program Office such as maintaining a good work environment, providing for career development and personnel related items must be met. A need exists to provide career development for future FAA Program Managers. Accordingly, functional organizations must provide for training and education of potential managers and specialists who may later fill important Program Office positions. Individuals so identified should fully understand matrix management principles at all organizational levels. They must also be given an opportunity to experience a variety of job assignments to expand their background and knowledge. The MLS Program Office effectively pursues these goals with the functional organizations to ensure that properly prepared and trained personnel are available for future program years.

MLS PROGRAM OFFICE ORGANIZATIONAL STRUCTURE AND RESPONSIBILITIES

The MLS Program Manager is responsible for establishing and supervising the MLS Program Office which is staffed at a level commensurate with current requirements. The Program Manager develops and documents the responsibilities of each element within the MLS Program Office. The Program Office implements and maintains an information tracking system capable of providing timely status reports on program progress using Development and Logistics (ADL) approved methods.

Program Office Organization

The functions and responsibilities of the MLS Program are developed along the same lines as those which are included in the MLS Program Manager's Charter. A copy of a typical program manager's charter is included in the Appendices. The Program Office is responsible for the design, development, test, evaluation, production, installation, and integration of MLS into the National Airspace System (NAS). Figure 4-1 depicts the MLS Program Office organization structure.

Program Office Responsibilities

The major functions and duties of the MLS Program Office are:

- Provides direction to and solicits, identifies, coordinates, and integrates the efforts of all participating organizations so as to ensure timely and effective accomplishment of mission.
- Initiates, directs, and coordinates the preparation of required program documentation, plans, and reports in accordance with the provisions of departmental and agency orders.
- Reviews, directs and makes recommendations concerning procurement request (PR) packages and specifications required for the development, production, and implementation of the MLS.
- Provides the leadership and direction

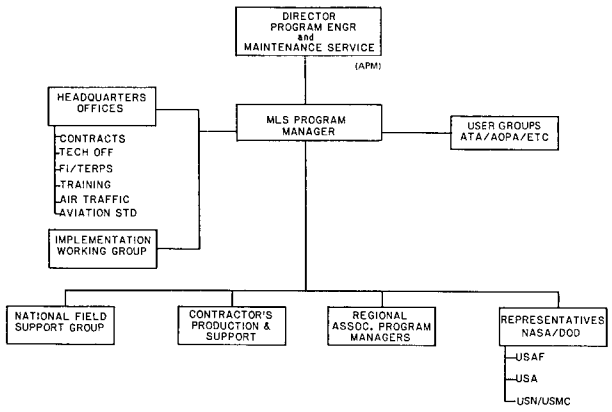

Figure 4-1: MLS Program Office

necessary for arriving at agency decisions on installation priorities and site location schedules.

- Ensures that determinations of decommissionings and consolidations are made consistent with existing policy criteria and are supportive of national planning so as to best acccmmodate users' requirements.
- Develops and maintains (with appropriate performing organizations) all MLS budgetary requests, reports, reprogramming, and other aspects of the MLS budgetary process.
- Assures the adequacy of financial resources to participating organizations supporting the MLS Program.
- Implements and maintains a program control and tracking system to support the management process and provides for timely status on program accomplishments.
- Assures the application of agency configuration management procedures to the MLS Program.
- Coordinates MLS Program activities with those of other related agency programs in the NAS Plan.
- Recommends to the Administrator, after consultation with performing organizations and appropriate executive level coordination through FAA Systems Acquisition Review Committee (ASARC), any indicated revisions to requirements and resources necessary to accomplish the mission.
- Serves as a liaison to other government agencies and groups from the aviation user community.
- Serves as spokesman for the MLS Program and disseminates MLS Program information in accordance with FAA and DOT regulations.
- Serves as focal point for interdepartmental, congressional, and public coordination of the MLS Program.
- Reports program status to ASARC quarterly or as required.

When required, the Program Office will be involved with each support organization in the negotiation of offical agreements. Known as Program Directives (PD), these agreements will spell out the task to be performed, products to be delivered, time schedules, and resource requirements. A signed PD will commit the functional organizations to satisfactory completion of agreed upon tasks within the allotted time frame. The PD concept will facilitate effective tracking of supporting organizations' activities and, in so doing, offer greater potential to the Program Office to minimize adverse schedule impacts.

FAA HEADQUARTERS AND FIELD INTERFACE

The MLS Program Office interfaces with and receives direct support from many FAA organizations in headquarters and the field. Figure 4-2 highlights the importance of the Program Office's ability to work with and direct the activities of the MLS program utilizing matrix management techniques. The Program Office must effectively interface with and receive support from at least 30 major internal FAA organizational elements. The figure does not include the various segments of industry and numerous aviation organizations that must be a part of the matrix scenario for successful program accomplishment.

The relationship between the headquarters and the field organizations is best summarized as one of coordination and communication accompanied by guidance and direction from the Program Office. In this relationship, the Program Office must bring diverse groups together to meet a common goal. A typical meeting might be between field TERPs, Flight Inspection, and

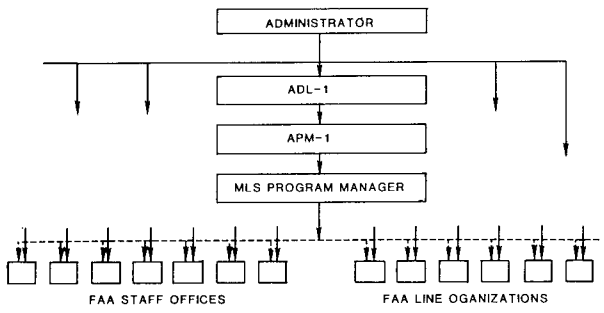

Figure 4-2: MLS Matrix Management Organization

&E engineering personnel together with headuarters Contract Engineers and ATC proedures specialists to arrange for the commisoning or test of a new MLS system. The Proram Office is responsible for bringing these roups together, for ensuring that specific goals nd objectives are set and that such activities ıove logically towards meeting the specified end esults.

In order to establish a good working relationıip between the organizations and individuals in the FAA headquarters and field, all parties must have a thorough understanding of the overall program. To this end, the Program Office has established many activities to inform interested parties about the various phases of the MLS program. These activities include the Regional Associate Program Managers' Conference, establishment of organizational focal points, MLS Implementation Working Group Meeting, and the development and dissemination of informative publications by the Program Office.

CONTRACTORS AND CONTRACT MANAGEMENT

The Program Office has the responsibility to eview and monitor all FAA contracts which ave a direct bearing on the MLS Program.

The technical management of the MLS proram as related to the ground system is the esponsibility of the Approach and Landing Proram Office (APM-410) of the Navigation and anding Division (APM-400). Accordingly, APM-410 has overall technical management esponsibility on the MLS ground system prouction contract whereas the Program Office has nly oversight and coordination responsibilities ı relation to the production contract. The Proram Office Staff provides policy guidance and irection to APM-410. The Program Office may ıterface directly with management level contracor personnel on matters which require coordinaon on overall MLS program implementation. hey do not, however, become directly involved ith contract personnel on matters that may afect or change contractual obligations.

Coordination and Responsibility

The coordination of the ground system intallation activities must be monitored and ıanaged to ensure that both the contractor and AA understands their respective responbilities. To preclude any misunderstanding, the oles of the FAA and the MLS contractor have een defined to ensure that the installation and ommissioning work proceeds in an efficient and mely manner.

Contractor Role

FAA MLS installation will be contracted on a Contractor Furnished Installation (CFI) basis with the contractor assuming a large share of the responsibility up to the actual certification of the facility. The contractor will:

- Provide MLS equipment, materials and personnel services.
- Provide special test equipment.
- Provide a completely detailed engineering report including site survey, recommendations for equipment location, routing of telephone and power lines, access roads, and installation drawings.
- Prepare and clear sites.
- Complete construction work and install equipment.
- Tune up equipment and complete preliminary checks prior to flight inspection.
- Complete preliminary flight check.
- Complete 120-hour stability run.

FAA Role

The responsibilities of the FAA will be to:

- Specify airport, heliport, runway, frequencies, and type of equipment.
- Acquire land.
- Determine TERPS requirements.
- Provide right of way.
- Provide airport information charts.

- Provide Supply Support and Maintenance.
- Review contractor's engineering report.
- Provide technical reports during installation as necessary.
- Complete commissioning flight inspection.
- Certificate facility.
- Develop and publish approach charts.

Small Contractors

The staff of the Program Office has day-t day contact with a variety of small contracto that directly support the MLS Program. A though they do not perform the work of a ministering the contracts, the staff may be i strumental in developing the tasks, requiremen and work statements for specific contract a tivities being conducted by other organizatior

MLS PLANNING

This section examines the Program Office's role in the planning process and budget development.

MLS Planning Process

The early phases of MLS planning are complete. They generally moved along the lines described in the MLS Transition Plan and accomplished the following:

- Outlined the optimum way to introduce the proposed Microwave Landing System into the National Airspace System as the replacement for the existing Instrument Landing System.
- Provided for an MLS Service Test and Evaluation Program (STEP) which included test and evaluation work at operational field facilities. Test facilities were installed at Washington, D.C.; Philadelphia, Pennsylvania; Atlantic City, New Jersey; and Clarksburg, West Virginia. These systems were established for evaluation only; therefore, they will not be commissioned.
- Provided a series of concepts and strategies from which a program implementation plan evolved.
- Provided for a three-phase MLS implementation strategy to be completed over a 15-year period.
- Established a baseline procurement plan for 1,250 MLS ground systems at a total estimated cost of $1.1 billion in 1981 dollars for Facilities and Equipment (F&E).
- Arranged for public input regarding the proposed implementation strategies and the benefit/cost study findings prior to proceeding with implementation. Public hearings were held in January 1981.

The FAA is moving toward the initial install tion of MLSs as defined in Phase I of the MI Transition Plan. The Program Office is now i volved with the production and delivery of MI systems being provided under the first multipl year contract. The number of systems to be pr cured in each fiscal year (FY) under the contra are as follows:

FY	BASIC	OPTIONS
82	15	—
83	15	—
84	22	6
85	60	10
86	60	20
TOTAL	172	36

The 30 Systems purchased with FY 82 and F 83 funds are those that will be installed in a cordance with the Transition Plan. Through tl implementation of these systems, the Progra Office will gain knowledge and experience in e tablishing hub and network airports which w further assist future MLS Program implement tion. The first MLS systems under this pha should be commissioned during the last half calendar year 1986 and continue on into 198

The current Hazeltine Corporation contra will provide enough systems to complete Pha I and begin Phase II. Follow on contracts w be required to complete the program and a now under consideration. The follow on co tracts will also include 326 additional systems satisfy the requirements of DOD.

MLS Funding

Program funding for the implementation of ıe MLS ground facilities is based on the installaon of 1,250 ground systems at an estimated cost f $1.1 billion in 1981 dollars. The funding is rovided by FAA under its F&E Program.

The Department of Transportation authorizd the FAA to proceed with the acquisition of ,250 MLS systems, subject to availability of ınding, by KDM dated April 8, 1983. The funing for MLS under the F&E program is inluded in FAA's annual budget. The Program)ffice has the responsibility to ensure that all actors are taken into account to provide suffiient funds for implementation consistent with pproved planning schedules.

This is not limited only to the F&E equipment ontract. The Program Office must ensure that ınding is allocated and made available for F&E eld support by the regions as well as other ofices or organizations that do work as part of ıe F&E MLS activity. Some of the activities reuiring funding oversight on an annual basis are s follows:

- That funds are available annually to support the multi-year MLS equipment contract.
- Providing estimates to the Regions for their F&E field support. The Program Office monitors financial requirements so that it is accurately reflected in the F&E call for estimates annually.
- Program Office must provide for F&E funding to other organizations which are providing direct F&E support under Program Directives. Organizations having such requirements include ACT, AVN, APT, etc.
- Funds must be programmed and provided for all direct F&E support contracts other than MLS system contracts. These requirements may not be large, but are vital to MLS system implementation.
- The Program Office must be aware and oversee funding for organizations outside FAA which are providing direct F&E support, such as support by DOD or NASA for FAA under interagency agreements.
- The Program Office must be cognizant of and provide the necessary input to the budgetary process for its own fiscal resources which are a part of the Operations Budget.
- All changes and reprogramming of activities requiring funds within current approved budget years must be monitored and managed by the Program Office.

IMPLEMENTATION SCHEDULE

The MLS implementation schedule is affected y several major activities, including budgeting, ite selection, procurement, procedures developıent, field engineering and support, DOD inolvement and avionics equipment availability. 'urther, these efforts lead directly to the installaion and commissioning of the MLS ground sysems. The MLS System Implementation Plan SIP) is the final word on MLS Implementation. 'he latest version of this document, Order 830.1A, is dated October 31, 1984. The MLS 'rogram Office is responsible for the mainteance and update of this document.

MLS Delivery Schedule

Contract delivery schedules dictate how many systems will be available in a given year for installation and commissioning. This number differs from the number of systems being purchased under budgetary authority for a given FY. The Program Office uses the contract delivery schedule as the basis for MLS installation scheduling. The Approach and Landing Program Office is responsible for maintaining and modifying the contract delivery schedule.

MLS Readiness

The regions must ensure that all preliminary site work is complete and that preplanned engineering and site preparation is conducted. They must arrange for all coordination with affected airports and ensure that all regional project engineering is accomplished. Also, the regions must

coordinate with the MLS contractors and APM-320. They must ensure that sufficient ground technicians and engineers are available for Flight Inspection (FI) and all arrangements are made for MLS facility commissioning.

To ensure MLS readiness, there are two major tasks required of the Aviation Standards National Field Office, AVN, as described below.

- MLS Facilities are planned to be commissioned at a rate of approximately 100 per year until all 1,250 are installed. Each of these will require commissioning Flight Inspection (FI) as well as periodic inspection thereafter. To do this the Program Office and AVN must ensure that all appropriate MLS FI procedures are developed, approved, and available and that sufficient aircraft and crews are available to handle the workload.
- Terminal Instrument Procedures (TERPS) must be completed prior to the commissioning of MLS sites. This requires that standards be developed and available for all operationally practicable flight profiles in the approach and departure phase of flight. Initially, the program is limited to higher priority tasks that can be accomplished in the near term with available resources. Much of the criteria for conventional takeoff and landing (CTOL) and straight in approaches are currently available. Program planning currently indicates that MLS TERPS criteria and development be completed for all type of approaches and procedures by the end c 1988. The key to this development is that it me the implementation schedule from now unt 1989 so that commissioning schedules occur a planned. This requires close coordination an communication between the Program Office an AVN. After the development of the criteria AVN and the regions have the continuing tas of ensuring that operational requirements ar met by applying and establishing the procedure to each operational MLS facility. They must als see that these are published.

MLS Program Master Schedule

The MLS System Implementation Plan is document which outlines activities to be cor ducted by FAA to plan, control and manag MLS system acquisition and deployment. Spe cific tasks and schedules are laid out for th organization which play a direct role in the im plementation. A Program Master Schedule, Fig ure 4-3, shows the time phasing relationship be tween program management, ground equipmer acquisition and implementation activities.

The Program Office has the responsibility c ensuring that the implementation schedule is de veloped, maintained and adhered to within th confines of MLS Program requirements.

PROGRAM OFFICE AND USERS

One very important phase of MLS implementation is the acceptance of the MLS by the user groups. In the early years of the development, 1978 and 1979, a series of MLS demonstrations were conducted by the U.S. under the auspices of ICAO. Equipment was transported by FAA to 12 airports around the world to demonstrate the performance, reliability and ease of set up. Following that, in 1979, FAA began the "STEP" program to gain additional experience in all areas. The STEP installations were not certified for instrument operations but many VFR approaches were made by Regional Airlines equipped to participate in the program. Information and data on such operations was co lected and made available to the users.

Various activities, such as the above, hav been underway since the outset of the program The Program Office has full responsibility to en sure that these efforts continue and that result are made available to the users. An ML demonstration program at Richmond, Virginia was started in July 1985.

An important objective of this demonstratio is to obtain wide participation by user group utilizing that airport. Such users will be equippe

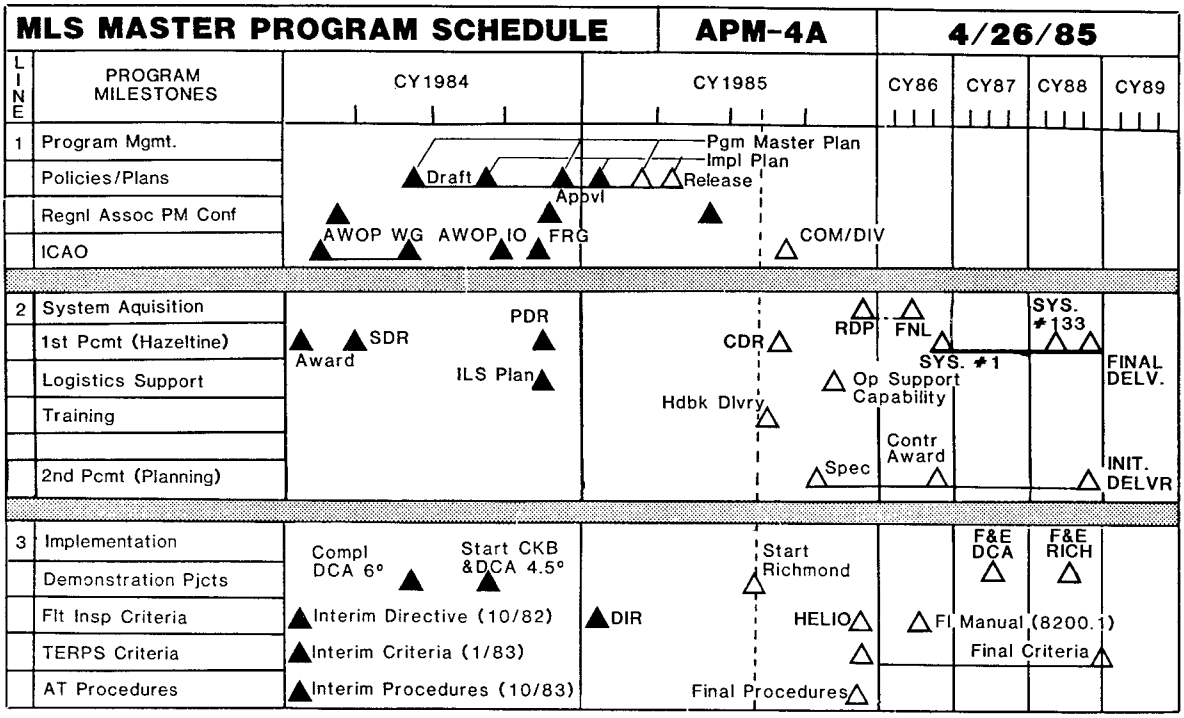

Figure 4-3: MLS Program Master Schedule

ith FAA approved MLS avionics and will pro-
de operational feedback on system perform-
ıce. This facility will be commissioned and may
: used by users other than those involved in the
:monstration.

The Program Office is planning other such
er programs. In the Eastern and New England
:gions, MLS equipment is planned for early
:livery from the FAA production contract. The
)jective of this program is to obtain early ex-
rience in a very active operational environment
volving air carrier jet aircraft.

The Program Office has worked closely with
e states and the USAF who have commissioned
e world's first MLS sites. The first commis-
)ned system was in Valdez, Alaska, in October
82, followed by Shemya, Alaska, in March
84, and Cadillac, Michigan, in August 1984.
ıe state of Michigan has two additional sites
/aiting commissioning at Sturgis and Bellaire.
formation gained by the operation of these
es will provide further useful information to users and the FAA in the early years of the program.

Keeping the users abreast of the program and providing them with current operational data is only a part of the Program Office's involvement with the users. Concentrated efforts were and are continuing to be made with various user groups to make sure that their views are considered and included in the implementation planning process. For example, users were asked to comment on priority lists of candidate sites for selection. The Program Office arranges and provides briefings to the users so as to keep them current. In addition, all user groups have direct access on a day-to-day basis with the Program Office on matters of importance.

The Program Office's objectives in terms of the user groups are as follows:

- Keep user groups informed.
- Make them a part of the implementation planning process.

- Provide MLS facilities early in the program that will give users hands on experience.
- Keep an open and direct communications line between the users and FAA.
- Listen to user inputs, pro and con, to develop a better MLS program.

The users are a very important element in t development of this program. In fact, along wi the interest for improved efficiency and safet they are the major reasons why MLS is bei implemented.

MLS PROGRAM OFFICE SUMMARY

This chapter provides an understanding of the many and diverse activities of the MLS Program Office in managing the MLS program. Through matrix management and the hard work and dedication of many specialists in many organizations, the Program Office manages, controls and directs the MLS Program.

The formula for success on this program is one which requires the utmost of personnel assigned to the Program Office. They must be able to work with others and find viable solutions to the accomplishment of established goals. Because of the small size of the Program Office Staff, each member must have a broad background and be able to work as a generalist in other disciplines. These requirements were taken into account when the office was established and personnel identified.

The Program Office has now moved the MLS Program to the verge of implementation. The first production systems will be installed in t last part of 1986. At that point, MLS will i troduce a new era in the capabilities of approa and landing. However, the planning for MI implementation was not limited to the U.S. North America but has been fully coordinat and accepted internationally.

The major objectives of the Program Offi is to continue with the implementation of t 1,250 MLS facilities within the planning fram work and within program costs. There is sor thought that a more accelerated program m lead to additional cost savings and this is und consideration. An accelerated program wou certainly lead to early MLS availability a utilization for the user groups. However, oth factors must also be assessed by the Program C fice and appropriate decisions made by FAA t management. With these considerations and t present objectives in mind, the MLS Progra will systematically proceed and provide for orderly transition from ILS to MLS.

Chapter 5

MLS PROGRAM IMPLEMENTATION AND OPERATION

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CHAPTER 5
MLS PROGRAM IMPLEMENTATION AND OPERATION

INTRODUCTION

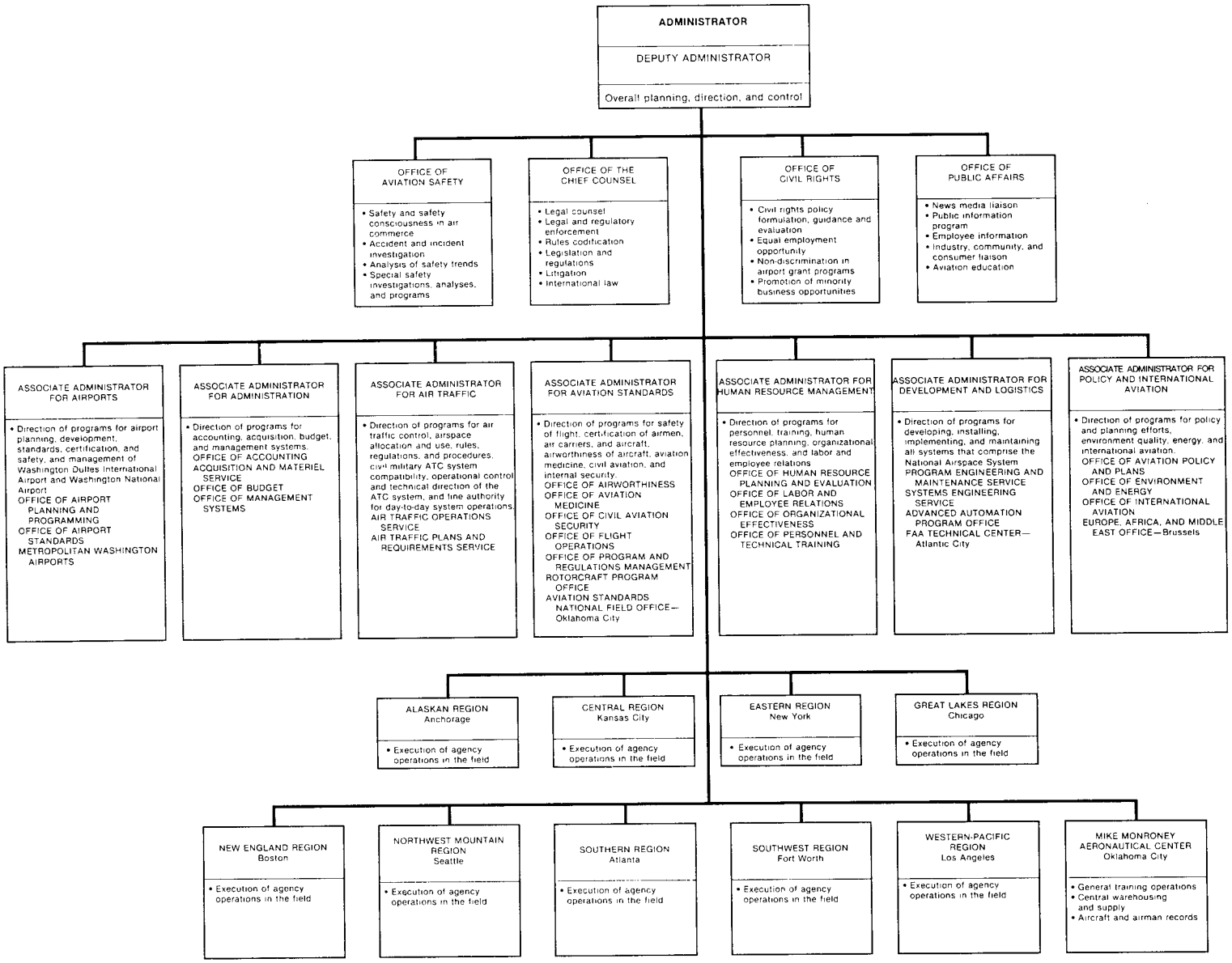
As discussed in the preceding chapters, MLS vill replace ILS as the new all-weather precision ıpproach and landing guidance system for the J.S. National Airspace System (NAS). Also, ılLS has been selected by the International Civil \viation Organization (ICAO) as the system to eplace ILS for international use. Present plan- ıing calls for full implementation of MLS in the J.S. by the year 2000. Although gradual, this ransition will require the collocation of MLS :quipment at existing ILS ground facilities for ı substantial period of time while aircraft owners ınd operators acquire MLS avionics equipment ınd operator competency.

For a better understanding of MLS Program mplementation, the reader should examine in- ıepth the organizations within FAA that play ı role in the implementation process (see Figure 5-1). As stated in Chapter 4, the Administrator ıas designated an MLS Program Manager who s supported by a small staff known as the MLS Program Office. This office provides manage- ıent and oversight and serves as the focal point :or MLS Program monitoring and control. Spe- :ifically, this includes guidance and support to FAA organizations that are a part of and pro- vide support to the MLS Program. Normally, :he identification of major tasks and require- ments are transmitted to FAA support organiza- :ions in the form of Program Directives. Other :asks may be identified by memorandum or in :he form of action items resulting from MLS meetings and program briefings such as the ASARC quarterly reviews. Any significant :hange to the MLS Program must be approved by the FAA Administrator. These and other ac- tivities translate into direct program support by FAA organizations that play a part in the MLS Program.

The Office of the Administrator, AOA, headed by the FAA Administrator, is the highest level of authority and responsibility in the FAA. The Administrator has overall responsibility for the operation of FAA. He is the Chairman of the ASARC which is charged with the top level management, review and approval of all Designated Major System Acquisition (DMSA) programs. The MLS program is a major F&E program which is included in this process. The MLS Program Manager is accountable to the Administrator for the planning, monitoring and accomplishment of the MLS Program.

Naturally, the level of participation by FAA organizations varies based on the different phases of the program. For example, the Office of Aviation Policy and Plans was more deeply involved in the program during the early planning period and throughout the development of the Transition Plan than it is or will be during the implementation phase. This is not to suggest that this organization does not have an important role in this phase, but merely indicates that its level of effort at present is less than it was earlier. On the other hand, some offices, such as Development and Logistics and Aviation Standards, have had and will continue to have a high level of involvement throughout the program. Two examples follow:

Development and Logistics (ADL) was instrumental in the MLS ground system development and is the major FAA organization responsible for the acquisition of the MLS ground system hardware. It was the lead element of FAA's involvement in the Research and Development activities in the 1970s and played a significant role in the selection by ICAO in 1978 of the Time Reference Scanning Beam (TRSB) MLS as the international standard. The organizational elements of ADL have since moved forward with the planning phases of the program and are currently concentrating on MLS implementation.


ADMINISTRATOR
DEPUTY ADMINISTRATOR
Overall planning, direction, and control
OFFICE OF AVIATION SAFETY
• Safety and safety consciousness in air commerce
• Accident and incident investigation
• Analysis of safety trends
• Special safety investigations, analyses, and programs
OFFICE OF THE CHIEF COUNSEL
• Legal counsel
• Legal and regulatory enforcement
• Rules codification
• Legislation and regulations
• Litigation
• International law
OFFICE OF CIVIL RIGHTS
• Civil rights policy formulation, guidance and evaluation
• Equal employment opportunity
• Non-discrimination in airport grant programs
• Promotion of minority business opportunities
OFFICE OF PUBLIC AFFAIRS
• News media liaison
• Public information program
• Employee information
• Industry, community, and consumer liaison
• Aviation education
ASSOCIATE ADMINISTRATOR FOR AIRPORTS
• Direction of programs for airport planning, development, standards, certification, and safety, and management of Washington Dulles International Airport and Washington National Airport
OFFICE OF AIRPORT PLANNING AND PROGRAMMING
OFFICE OF AIRPORT STANDARDS
METROPOLITAN WASHINGTON AIRPORTS
ASSOCIATE ADMINISTRATOR FOR ADMINISTRATION
• Direction of programs for accounting, acquisition, budget, and management systems.
OFFICE OF ACCOUNTING
ACQUISITION AND MATERIEL SERVICE
OFFICE OF BUDGET
OFFICE OF MANAGEMENT SYSTEMS
ASSOCIATE ADMINISTRATOR FOR AIR TRAFFIC
• Direction of programs for air traffic control, airspace allocation and use, rules, regulations, and procedures, civil military ATC system compatibility, operational control and technical direction of the ATC system, and line authority for day-to-day system operations.
AIR TRAFFIC OPERATIONS SERVICE
AIR TRAFFIC PLANS AND REQUIREMENTS SERVICE
ASSOCIATE ADMINISTRATOR FOR AVIATION STANDARDS
• Direction of programs for safety of flight, certification of airmen, air carriers, and aircraft, airworthiness of aircraft, aviation medicine, civil aviation, and internal security.
OFFICE OF AIRWORTHINESS
OFFICE OF AVIATION MEDICINE
OFFICE OF CIVIL AVIATION SECURITY
OFFICE OF FLIGHT OPERATIONS
OFFICE OF PROGRAM AND REGULATIONS MANAGEMENT
ROTORCRAFT PROGRAM OFFICE
AVIATION STANDARDS NATIONAL FIELD OFFICE—Oklahoma City
ASSOCIATE ADMINISTRATOR FOR HUMAN RESOURCE MANAGEMENT
• Direction of programs for personnel, training, human resource planning, organizational effectiveness, and labor and employee relations
OFFICE OF HUMAN RESOURCE PLANNING AND EVALUATION
OFFICE OF LABOR AND EMPLOYEE RELATIONS
OFFICE OF ORGANIZATIONAL EFFECTIVENESS
OFFICE OF PERSONNEL AND TECHNICAL TRAINING
ASSOCIATE ADMINISTRATOR FOR DEVELOPMENT AND LOGISTICS
• Direction of programs for developing, installing, implementing, and maintaining all systems that comprise the National Airspace System
PROGRAM ENGINEERING AND MAINTENANCE SERVICE
SYSTEMS ENGINEERING SERVICE
ADVANCED AUTOMATION PROGRAM OFFICE
FAA TECHNICAL CENTER—Atlantic City
ASSOCIATE ADMINISTRATOR FOR POLICY AND INTERNATIONAL AVIATION
• Direction of programs for policy and planning efforts, environment quality, energy, and international aviation.
OFFICE OF AVIATION POLICY AND PLANS
OFFICE OF ENVIRONMENT AND ENERGY
OFFICE OF INTERNATIONAL AVIATION
EUROPE, AFRICA, AND MIDDLE EAST OFFICE—Brussels
ALASKAN REGION
Anchorage
• Execution of agency operations in the field
CENTRAL REGION
Kansas City
• Execution of agency operations in the field
EASTERN REGION
New York
• Execution of agency operations in the field
GREAT LAKES REGION
Chicago
• Execution of agency operations in the field
NEW ENGLAND REGION
Boston
• Execution of agency operations in the field
NORTHWEST MOUNTAIN REGION
Seattle
• Execution of agency operations in the field
SOUTHERN REGION
Atlanta
• Execution of agency operations in the field
SOUTHWEST REGION
Fort Worth
• Execution of agency operations in the field
WESTERN-PACIFIC REGION
Los Angeles
• Execution of agency operations in the field
MIKE MONRONEY AERONAUTICAL CENTER
Oklahoma City
• General training operations
• Central warehousing and supply
• Aircraft and airman records

n that regard, ADL units are involved as ollows:

- The Program Engineering and Maintenance Service (APM) has the responsibil-ty for the engineering, development of specifica-tions, and the management of the acquisition of MLS ground system hardware. The MLS Pro-gram Office is a part of APM.
- The FAA Technical Center (ACT) has the responsibility for testing and evaluating MLS equipment and procedures, and computer math modeling. It also participates in developmental work consistent with implementation plans and strategies. A major Technical Center MLS de-velopmental activity is MLS siting at a heliport. The Technical Center also provides technical as-sistance to APM in support of the acquisition of MLS ground system hardware.
- The System Engineering Service (AES) serves in a key role by coordinating and manag-ing the FAA NAS Plan. AES also provides a ma-jor support role through the management of the System Engineering and Integration contract (SEI). The SEI contractor (Martin Marietta) has a significant role in the planning and implemen-tation of the MLS Program.

Aviation Standards (AVS) is a major FAA organizational entity involved with aircraft avi-onics, Flight Inspection, and the operational por-tions of the MLS Program. Some of the major program elements that must be performed by the AVS organization include:

- The development, verification and is-suance of Terminal Instrument Procedures (TERPS) for MLS. The majority of the work in this area will be done by the Aviation Stan-dards National Field Office (AVN) in Oklahoma City, Oklahoma. This work is being performed in accordance with a Program Directive between AVN and the MLS Program Office.
- The identification and selection of MLS candidate sites is subject to the guidance and ap-proval of the Program Management Division, APR-100. This activity includes the budgetary process with the regions, Program Office and the user groups. It will be a continuing activity throughout the life of the program.
- The development and implementation of Flight Inspection (FI) procedures. Also, the scheduling and FI of MLS facilities as they come on line following installation by the contractor. This activity is primarily the responsibility of the Flight Programs Division, AVN-200, in Okla-homa City.
- The Management and monitoring of the development, preparation and oversight of AVS developed procedures and policy matters. Also, the establishment of special MLS demonstration programs, such as the Richmond MLS Demon-stration Program, is the responsibility of the Of-fice of Flight Operations (AFO).
- Ensuring that requirements are met and that engineering drawings and other applicable documentation are available to obtain Supple-mental Type Certificates (STC) for the installa-tion of MLS Avionics equipment on specific air-craft. This effort requires cooperation between AFO and the Office of Airworthiness (AWS). The AWS organization is responsibile for ap-proving the various STCs.
- The coordination and implementation planning and demonstration activities attendant to providing MLS as part of the all-weather Heli-port Development and Demonstration Program is a joint effort by FAA's Rotorcraft Program Office (ARO) and the Helicopter Program Of-fice, APM-720. Four cities have been selected for FAA's National Prototype Demonstration Program: Indianapolis, Los Angeles, New Or-leans and New York. These locations are to be equipped with MLS for all-weather operations.
- All AVS offices will be involved in ongo-ing coordination and liaison with the user groups to ensure that their concerns and inputs are con-sidered on all applicable policy and program im-plementation matters.

Understandably, it is important that ADL and AVS work closely together in the implementa-tion process as they are the two organizations with the greatest involvement in the overall MLS Program. They are followed closely in this role by the FAA regions who actively participate in the actual establishment of the MLS ground fa-cilities. There are, however, many other offices and services that have important roles in the MLS implementation process. For example, the Air Traffic Service has the responsibility for the development of ATC procedures and the actual operational requirements for utilizing MLS as

an aid for landing and departing aircraft in the terminal ATC environment. The Associate Administrators for Airports, Policy and International, and Administration; the Directors of the Aeronautical Center and the various FAA regions; and the Assistant Administrator for Public Affairs each have specific roles in support of the MLS Program. These roles and responsibilities will be explored in detail later in this chapter.

This chapter will be used to examine each individual FAA organization that plays a role in th MLS Program. Its past, present and future ef forts and planning activities, and its specifi MLS support function and how specific organi zations provide the required support or servic to the MLS Program will be defined. Once th role of the office is defined, it should be eas to visualize how it fits into the overall progran and how it can function in a matrix mode witl the other organizations in concert with the Pro gram Office.

DEVELOPMENT AND LOGISTICS (ADL)

This is a high level management and policy office headed by an Associate Administrator with two Deputy Associate Administrators, one for Development and Logistics and the other for Engineering. Specifically, ADL's responsibility is to manage and to establish FAA policy as related to the agency's programs in support of Airway Facility establishment and operation. The Associate Administrator reports directly to the FAA Administrator and serves as his top advisor on all matters pertaining to Development and Logistics.

Functions and Responsibilities

The ADL organization is responsible for the direction of programs for developing, installing, implementing, and maintaining all systems that comprise the NAS. The Associate Administrator for Development and Logistics has the responsibility for monitoring all of FAA's Designated Major System Acquisitions (DMSA). This includes being a key representative on the ASARC Quarterly Program Review for the Administrator and high level DOT officials. As previously stated, the MLS Program meets all the requirements for this high level review and attention. A significant amount of interest and attention is paid the MLS Program due to the following:

- Magnitude of the Program, which will provide for the establishment of 1,250 MLS ground facilities over a 15-year period at an estimated cost of $1.1 billion in 1981 dollars.
- The international ramifications of the program for the worldwide replacement of ILS with MLS, by the year 2000, as the ICAO standar precision landing system.
- The transition from ILS to ML throughout the U.S. over the next 15 years.
- The concerns and interests of the users an their participation in the MLS Program.
- The political and economic considerations in keeping the program on schedule to meet na tional requirements by the year 2000.

Deputy Associate for Development and Logistics

The Deputy Associate Administrator for De velopment and Logistics is also the NAS Pla Program Director (NPPD) with responsibilit for the management of the FAA's System Eng neering and Integration (SEI) contract for th establishment of the NAS System in accordanc with the NAS Plan. The MLS Program is an in tegral part of the NAS Plan and has a dire working relationship with the SEI contracto This relationship constitutes an additional ove sight role for ADL management.

Program Review and Analysis Staff

The ADL organization also has a Program R view and Analysis Staff, ADL-10. This offi functions as a high level budgetary and fiscal r quirements staff to ensure that financial r sources are available and to monitor and de with fiscal matters on an ongoing basis for a ADL programs. They are also responsible f the assessment of the need for personnel r sources within the ADL complex. Services of th

nature are provided to the MLS Program by the ADL-10 staff to meet its administrative needs.

Early ADL Involvement/Support of MLS

ADL has been examined as the parent organization for Development and Logistics. Major management, policy and support roles have been identified. The following information will review ADL's early involvement and support of MLS and then discuss ADL Development and Logistics specific responsibilities.

U.S. MLS Development (U.S.)

The ADL complex was responsible for FAA's management and direction of the MLS development program which was conducted under a National Plan jointly sponsored by DOT, DOD, and NASA. The program was structured to assess all viable alternatives and to identify the best MLS technique and hardware designs.

Prototype Development—In the prototype development phase, several systems were built by two contractors. These were tested extensively at various locations under different operational and environmental conditions. It was the prototype systems and the tests of these systems that provided the basis for a number of improvements and refinements both in the signal format and the system design requirements. These systems were also used in a series of operational demonstrations for ICAO.

During the operational tests and experiments of these prototypes, more than 2,500 MLS approaches were flown in typical conventional takeoff and landing (CTOL) aircraft (air carrier and general aviation), short takeoff and landing (STOL) aircraft, and vertical takeoff and landing (VTOL) aircraft. Control and display systems ranging from the simplest to the most advanced were tested. In the process, a number of operationally oriented procedures were developed in preliminary form. These were then used in the Service Test and Evaluation Program to develop finalized procedures. Taken together, the various technical and operational tests demonstrated that the system is technically mature and fully meets both the U.S. and the ICAO operational requirements.

Three representative configurations (i.e., a small community, a basic, and an expanded system) were chosen for development and tested for the many possible options which the flexibility of the signal format permits. The intent at that time was to examine three levels of performance capability and to evaluate a variety of packaging techniques and hardware design approaches.

Early Decisions—The experience with the prototype equipment and the maintenance concept developed for the MLS allowed the FAA to make a decision that a common modular system, based on the three separate prototype designs, was the correct production approach. This permitted a decision to eliminate the equipment shelters which in turn permitted a reduction in transmitter power since the electronics could now be collocated with the antenna.

Having accepted these changes, it became evident that the transmitters, power supplies, and monitors were functionally identical for all three levels. The only items that were different were the antennas (which had different apertures), and even those had commonality of components and could be constructed in modular form. It was logical to make use of this commonality of modular components, with the associated cost savings, to develop a system design that would satisfy the full range of operational and other performance requirements. This would allow for only modular changes or additions to the basic system to provide for upgrading and/or system growth. Based on this rationale, the best features of the three configurations were selected for inclusion in the standard design for FAA production equipment.

Standard System—The standard system includes Precision DME (DME/P) which is a compatible upgrade of the conventional DME currently in use with ILS and VOR. This approach is consistent with the ICAO position to include DME/P MLS capabilities of precision, three-dimensional navigation guidance throughout the coverage area. The cost of establishing a DME/P

is essentially the same as for the two marker beacons associated with ILS. During the transition period, at locations where MLS and ILS will be collocated, existing ILS marker beacons will be retained for use with MLS for a period of time depending on the extent of user equipage of DME or DME/P avionics. No new installations of marker beacons are planned for use with MLS.

ICAO MLS Development

The ICAO program to develop a new landing system was conducted in parallel with the U.S. program. In 1972, ICAO invited interested countries to submit system proposals to satisfy the operational requirements. Proposals were submitted by five countries (Australia, Germany, France, U.K., and U.S.). In 1978, after an extended period of evaluation and operational demonstration, the MLS technique developed and proposed by the U.S. and Australia was adopted for international standardization. Since 1978, the ICAO program has been directed toward obtaining approval of Standards and Recommended Practices (SARP). These standards for the angle and data functions were approved in April 1981, and now form a part of an amendment to Annex 10 to the Convention on International Civil Aviation. In December 1982, the standards for the range function (DME/P) were recommended for approval. These will become a part of Annex 10 in November 1985.

One of the highlights of the ICAO activity was a demonstration program carried out in 1977 and 1978. It was the objective of the ICAO Council to obtain as much information as possible on the proposed landing systems so that an informed decision could be made to standardize on a single system. In response, the U.S. conducted demonstrations at 12 locations around the world as a means of testing the system in a wide range of operational situations and environmental conditions. The demonstrations were conducted with the following aircraft: FAA (F-727, CV-880, CV-580, DC-6 and Twin Otter); USAF (T-39); and NASA (B-737). The locations were:

Cape May, New Jersey
Buenos Aires, Argentina
Tegucigalpa, Honduras
JFK Airport, New York
Kristiansand, Norway
Brussels, Belgium
Charleroi, Belgium
Dakar, Senegal
Nairobi, Kenya
Shiraz, Iran
Montreal, (Dorval Intl), Canada
Montreal (Victoria STOL Port), Canada

This program was very effective in demonstrating the performance, reliability, and ease of setup of the system.

MLS Service Test and Evaluation Program (STEP)

A Service Test and Evaluation Program (STEP), which has been discussed in previous chapters, was initiated in 1979 to provide operational experience to ease the transition from system development to implementation. The program used available prototype ground systems that were procured during the development program. However, a limited number of new airborne receivers had to be procured. Operational evaluations began with two commuter airlines Ransome and Aeromech. Ransome used the MLS on scheduled flights of the De-Havilland Dash-7 between Philadelphia, Pennsylvania, and Washington, D.C., Aeromech (currently Wright Airlines) used the system with the Embraer Banderante aircraft on flights between Washington, D.C., and Clarksburg, West Virginia. The avionics for these aircraft were provided by the FAA on a loan basis. STEP provided a broad spectrum of operationally useful data in a number of implementation areas such as Siting and Installation, Flight Inspection, Operations and Maintenance, Terminal Instrument Procedures Criteria, and Reliability and Maintainability.

The development of MLS has been carried to a stage where it is ready for implementation. It has been exhaustively tested within the United States and internationally and has demonstrated its ability to satisfy the operational requirements It employs state-of-the-art technology and displays no evidence of technical risk in the system design.

Development and Logistics Complex in Support of MLS

The Development and Logistics Complex includes four line organizations, three of which are involved in the MLS Program. They are:

- Program Engineering and Maintenance Service—Major effort and involvement with MLS Program.
- System Engineering Service—Some MLS Program involvement.
- FAA Technical Center—Significant MLS Program involvement.
- Advanced Automation Program Office—None or minimal program involvement.

Program Engineering and Maintenance Service (Airways Facilities)

This organization is easily identified with the Airway Facility segment of the various FAA Regional Facilities. In past organizational arrangements it was at times identified as Airways Facilities, Systems Maintenance, Facility Installation, etc. The major difference today is that it has multiple responsibilities such as Facility Engineering, Maintenance and Installations.

The Program Engineering and Maintenance Service (APM) is headed by a Director and has a major role in the implementation of the MLS ground facilities and equipment. This organization has several offices involved in the MLS program: MLS Program Office, Program Management Staff, Navigation and Landing Division, Maintenance Engineering Division, Aircraft Safety and Airport Technology Division (Helicopter Program Office) and all associated DOD involvement. The management and direction of most DMSA programs involving F&E equipment are the responsibility of APM and are reviewed and monitored by the director on an ongoing basis. The MLS Program is one of these programs.

Some of the APM offices which are involved in MLS Programs have been identified. The following paragraphs will examine their specific tasks and their role in the implementation process.

MLS Program Office—The MLS Program Office, APM-4A, is an organizational entity directly under and reporting to the APM Director. The purpose of the MLS Program Office is to manage, direct and control the overall MLS Program for the agency. It performs these tasks using matrix management techniques and principles. The staff of the office, which is small, provides guidance to the various FAA line organizations charged with the actual work programs to meet the requirements of the MLS implementation process.

Program Management Staff—The Program Management Staff, APM-10, provides administration, budget, personnel and management support to the MLS Program. Areas of support are:

- F&E Program Control—Provides for budgetary and fiscal control of current and future F&E programs. Handles the annual budgetary requirements, arranges for allocation of funds and provides for reprogramming of funds when necessary.
- R&D Program Control—Provides essentially the same services as the F&E except in the R&D area. In addition, it provides for a management information system to support all programs including MLS.
- Administrative and Management Support—Provides personnel management support and support in the establishment and updating of FAA directives. Also supports the MLS Program on all other administrative matters associated with APM's operations and responsibilities.

Navigation and Landing Division—The APM Navigation and Landing Division, APM-400, is responsible for the technical management of the MLS Program. Its responsibility includes the provision of equipment specification; the conduct of design reviews, hardware test and evaluation; the generation of site installation requirements; regional coordination; budget, maintenance, and logistics planning and scheduling. This work is delegated to and performed by the

Approach and Landing Program Office, APM-410. Some of the tasks of APM-410 are:

- Provide for the management and monitoring of MLS production equipment contracts.
- Arrange for all coordination and control for the field implementation of MLS from procurement contracts which provide for Contractor Furnished Installation (CFI). The contractor is responsible for site engineering reports, all site preparation, installation and preliminary flight tests. The government is responsible for the selection of locations and antenna configurations, providing airport drawings to the contractor, environmental impact statements, frequency assignments, land acquisition through the regional logistics division, approval of site engineering reports, resident site engineers, flight inspection and final acceptance. These items must be closely monitored by APM-410 to avoid any program delay.
- Ensure that MLS siting criteria are available in the form of an MLS siting handbook prior to the installation of the equipment. The handbook must then be reviewed and updated as required, particularly in the early years of the MLS Program.
- Monitor the Qualification Operational Test and Evaluation (QOT&E) part of the MLS Contract. It is a new procedure for FAA during a period following installation and flight inspection when the total system is evaluated for deficiencies or problems that could not be determined in prior factory testing. At the completion of QOT&E, the system should have undergone a thorough shakedown from an operational standpoint including hardware, personnel, procedures and training.
- Provide engineering support and procurement action to provide MLS receivers in the early phases of the program.
- Provide necessary coordination with aircraft manufacturers, NASA, DOD and others to stay abreast of MLS avionics and cockpit technology. This includes working closely with the cockpit Technology Program Office, APM-430.
- Provide coordination with and information to APM-4A on all APM-400 MLS and ILS program activities which require attention by the MLS Program Office.

Another activity of the APM-400 divisior staff is to coordinate a joint FAA/USAF Fligh Test Program. This program is intended to col lect data on large aircraft and to define equip ment requirements ensuring that the full capa bilities of MLS are realized. The program wil evaluate complex flight profiles and th MLS/ATC interface. Realism will be introducec to the extent feasible including introduction o a mix of aircraft, some of which will not be MLS equipped. The Wallops Island facility is being used since it has an ICAO formatted ground sys tem and an adequate tracking system. An Ai Force C-141 test bed aircraft and an L-101 simulator provide the data base. Commercial pi lots in the Air Force Reserve who are current ir the C-141 will be used in the program. After fly ing the procedures in the C-141, they will retur to the simulator to verify the data.

Maintenance Engineering Division—Th APM Maintenance Engineering Division APM-100, has responsibility for the maintenanc requirements of the Service and, as a part o that, the MLS Program. The Maintenance Oper ations Program Office, APM-110, is the offic most directly involved with the maintenance sup port tasks associated with MLS. The emphasi is on the FAA's presently planned '80 Maintenance Program.

MLS will be one of the first beneficiaries o the new maintenance program that the FAA i implementing in the 1980s. This program i based on the conversion of all equipment t solid-state technology, remote maintenanc monitoring of equipment, and centralization o the work force with minimum preventativ maintenance tasks. The primary consideratio in the design of the facilities and equipment i their ability to perform the intended functio reliably. The concept ensures the maintenanc of an ever growing inventory of equipment t be performed by a relatively small work force Repetitive and administrative tasks normall done by a technician are to be accomplished b a computer, thereby leaving the technician fre to perform high level, decision oriented work The central provisions of the program are th ability to remotely monitor the performance c

a facility, measure equipment parameters, predict imminent failures and make compensating adjustments or corrections. This requires sensors at the remote facility to feed up-to-date information over a telecommunications network to a central processor located at an Air Route Traffic Control Center, Terminal Facility or Sector Office. It will collect, process and analyze data and present the necessary information to technicians via a portable terminal at the remote facility, or where there is access to either a telephone or stationary terminal at a work center.

The MLS maintenance concept will improve productivity over ILS maintenance systems by providing more service at lower cost, reducing travel and labor-intensive tasks, conserving energy, and improving work force utilization. These improvements are made possible by the incorporation of remote maintenance monitoring functions in MLS equipment and implementation of the maintenance organization restructuring presented in the '80s Maintenance Concept Implementation Plan.

The MLS will be the first system designed from the start to utilize the '80s Maintenance Program concepts. Some of the key features of MLS which directly support the requirements of the '80s Maintenance Program are:

- Unattended operation of MLS facility
- Automatic remote continuous monitoring
- Maximum use of modular solid-state electronics
- Remote control and status information
- Routine maintenance visit every three months
- Remote diagnosis and fault detection
- On site replacement of defective modules

Use of the remote maintenance monitoring capabilities of MLS equipment will allow a major increase of the Airway Facilities work force capability. Technicians will be freed from bookkeeping and routine, repetitive tasks and permitted more time for analytical tasks and corrective maintenance. Changes in methods for preventive and corrective maintenance will allow fewer technicians to maintain more facilities.

The Maintenance Engineering Division, APM-100, has responsibility in the following areas for the support of MLS and other DMSA programs:

- Plan, develop and implement the '80s Maintenance Program to include the necessary elements to directly support MLS implementation schedule.
- Plan and develop with the regions, appropriate staffing standards to support MLS requirements.
- Take the lead in providing a training program which will reflect the maintenance concept, MLS design characteristics, and the latest training philosophy. The training requirements will be identified jointly with members of Air Traffic, Aviation Standards, and Personnel and Training.
- Have responsibility to provide second-level engineering support. This support will include configuration control and modification for all MLS hardware and software systems.

The role of APM-100 is large and important at this time and will remain so throughout the implementation process. APM-100's success in meeting its goals is instrumental in bringing MLS on line for commissioning in accordance with implementation schedules. The availability of the maintenance program staffing, second-level engineering support and the training of all engineers and technicians must keep pace with MLS implementation. These program elements are the critical milestones that must be met to ensure proper maintenance and operation of the MLS ground facilities once they have transitioned from the Contractor to the Airway Facilities maintenance organizations of the regions.

Helicopter Program Office—The Helicopter Program Office, APM-720, of the Aircraft Safety and Airport Technology Division is charged with providing technical and program support to the All-Weather Heliport Development and Demonstration Program as a part of FAA's Rotorcraft Master Plan. This Office provides a direct technical interface between the APM programs and the Rotorcraft Program Office.

The Rotorcraft Master Plan provides for an FAA-wide, 20-year plan to address the needs of the rotorcraft industry and the potential benefits to the public. The master plan envisions three major thrusts which include:

- Integration of helicopters into the NAS.
- Helicopter development.
- Certification improvements.

The national all-weather Heliport Development and Demonstration Program is planned for implementation at the following four locations: New York (Wall Street), New Orleans, Indianapolis and Los Angeles. These locations will be equipped with an all-weather capability including the installation of MLS and AWOS. It is anticipated that all-weather heliport networks will have been developed in 25 major urban areas by the year 2000.

The helicopter program interests as related to MLS are: development of procedures, benefits, rotorcraft avionics and MLS configuration for heliports. Procedures and MLS capabilities of particular interest to rotorcraft are:

- Curved/Segmented approaches and departures.
- Missed approach guidance.
- Offset approaches and simultaneous/closely spaced operations involving a mix of rotorcraft and fixed-wing aircraft.

The expected benefits include reduced delays, increased capacity, IFR approaches to heliports using an MLS located at a nearby airport, and lower minimums.

The Helicopter Program Office has the task of working with the MLS Program Office and the Rotorcraft Program Office to ensure that the MLS Program implementation provides for the needs of the Rotorcraft Program. It also provides the technical support and information to the MLS Program Office to provide for equipment, testing and procedures development which will support the planning and implementation of Heliport Development and Demonstration Programs.

DOD Involvement in MLS—As was discuss ed in previous chapters, there is a significan joint FAA/DOD involvement in the MLS Pro gram. The United States Air Force has bee assigned as the lead military service to worl directly with FAA throughout the implementa tion. There is a senior officer assigned to th MLS Program Office for the day-to-day coordi nation necessary to manage and arrange for th requirements of the DOD MLS Program and it interface with the FAA MLS Program. Ther is also a senior officer assigned to the Naviga tion and Landing Division to arrange for an coordinate the various FAA/DOD test program which are vital to the technical management o the program.

A significant part of the military program cor cerns MLS avionics. Over the next 15 year DOD will retrofit approximately 19,000 aircra with MLS capable avionics. The initial effort wi center on Military Airlift Command C-130 an C-141 aircraft which will be used in conjunctio with the tactical MLS. Commercial MLS cabi class receivers will be installed on these aircraf Other candidates for commercial avionics ar tanker and bomber aircraft. All together the are about 2,800 aircraft which could use con mercial MLS receivers. Procurement and insta lation of commercial avionics by DOD will begi in FY 87.

DOD's key program management areas wi center on manpower, training and maintenanc requirements as MLS is phased in and ILS Precision Approach Radar, and TACAN ar phased out. DOD's published MLS Implement tion Plan (August 1983), which is updated annu ally, is integrated into the FAA MLS System In plementation Plan. The close cooperation an joint efforts between the FAA and DOD on th MLS Program have proven to work well and i the best interest of both organizations.

Systems Engineering Service

The Systems Engineering Service (AES), is th FAA organization that is responsible for manag ing the SEI contract. The SEI contractor charged with the implementation of the NA Plan. MLS, as previously discussed, is a part c

he NAS Plan. Other AES responsibilities to the ILS Program include the top-level MLS design ınd the frequency management requirements de-'elopment. Overall, AES supports the MLS Pro-;ram by providing system engineering and tech-ıical policy guidance.

SEI Contract—The Systems Engineering Serv-:e (AES) is the organization that was responsible or the competitive award of the SEI contract ı early-1984. The contract, which covers a five-'ear period plus a three-year option and then a wo-year option, was won by Martin Marietta. t is a cost plus award fee contract where the fee ; based on the FAA's assessment of perform-nce. The total worth of the contract could be ıver $700 million. The scope of the contract overs the entire F&E program and a small por-ion of R&D and training. The entire NAS af-ected by the system design will be audited and ıventoried in 1984 and 1985 by the SEI ontractor.

The SEI contractor is responsible to the FAA or implementation of the NAS Plan. As part f that responsibility, Martin Marietta will be roviding direct support to the MLS Program)ffice. The SEI contractor's primary role is two-old: (1) to support both APM-4A and APM-400 ı the successful development and deployment f MLS, and (2) to assure that the MLS Pro-ram is integrated into the overall NAS. SEI sup-ort to the MLS Program Office will include: :viewing program documentation, developing ıtegrated schedules, defining MLS to NAS in-:rfaces and providing program management nd technical integration expertise. A group of EI contractor personnel have been assigned to nd are working with the MLS Program and en-ineering personnel.

The Martin Marietta group assigned to the ILS Program initially did an audit of the pro-ram. The purpose of the audit was to discover sues which might present problems in effecting nplementation; none were found. The group as participated in the Hazeltine MLS procure-ıent contract Preliminary Design Review 'DR); developed a management action data base which allows tracking of action items; assisted in the preparation and tracking of the operational procedures development programs; prepared a draft Program Master Plan; and established a system for processing changes in MLS design. Overall, the group has been very effective and has provided needed support towards the implementation of the MLS Program.

Frequency Management—The AES Spectrum Engineering Division, AES-500, is responsible for frequency management and ensures that all MLS equipment is installed on a noninterference basis and provides overall NAVAID coverage maps.

The MLS frequency situation starts out somewhat better off than today's ILS environment. Unlike ILS where there are only 40 ILS channels available and frequency congestion is becoming a serious problem in several parts of the country, 200 MLS channels are available for the estimated 1,250 systems planned for implementation. Separate paired angle and DME frequencies comprise one MLS channel which is numbered from 500 through 699. The first 100 channels were obtained by pairing MLS with the existing ILS/DME and many of the VOR/DME frequencies. These are available for assignment through 1995 at which time the second hundred channels will be available for assignment. Because of the omnidirectional characteristics of the DME, that system tends to be the limiting factor in terms of the maximum number of systems which may be established given the 200 channels available.

In an ideal situation, ILS and MLS should be on the same channel when both are installed on a runway. However, this must be examined on a case-by-case basis. The regions will be responsible for initiating any frequency changes needed to accomplish this objective. The headquarters Frequency Engineering Office will assist by providing necessary guidelines. The frequency assignments will be made and approved by the Spectrum Engineering Division, AES-500, for the initial MLS implementation.

Technical Center

The FAA Technical Center (ACT) has a significant role in the MLS implementation process. The Technical Center is involved in the flight testing and data processing associated with the development of MLS operational procedures. In addition to this activity, the center supports APM in the acquisition of ground systems hardware and is assigned special projects in direct support of MLS implementation. The major portion of the MLS project activities are managed by the Center's Engineering Division, ACT-100. Some of the specific activities that are being managed by ACT are identified in the following paragraphs.

Mathematical Modeling—The Guidance and Airborne Systems Branch, ACT-140, has the responsibility for the development and maintenance of a baselined and configuration controlled computerized MLS Mathematical Model. The Mathematical Model will be used to predict the performance which may be expected from an MLS installation at a specific location on an airport. The Model, in determining the radiated MLS signal characteristics, will take into account the surrounding terrain, geometry, and texture of the various reflecting and shadowing objects. The computerized model, which was originally derived from the MIT Lincoln Laboratory Model, has been improved over the years and is still being improved as additional experience is gained. The Technical Center's modeling services will be available to the regions and the MLS contractors throughout the MLS implementation phases. These services will also be available for other nonfederal and international requirements. The center also has an ILS Mathematical Model, originally developed by the Transportation Systems Center and Ohio University. It should be noted that the Technical Center has the overall project control for the development, operation and program use of the modeling services.

Helicopter Procedures Development—The Technical Center has provided facilities and support services to facilitate the testing of procedures for the Heliport Program. This work is in direct support of the All-Weather Helipo Development and Demonstration Program. E tensive heliport MLS data has been collected t support the development of helicopter MLS te minal instrument procedures (TERPS).

ATC Simulation Laboratory—The AT Simulation Laboratory at the Center will be us to test MLS ATC procedures in a simulated, li environment. These tests will be highly benefici in determining the adequacy of the new MI ATC procedures in high density areas with a m of aircraft types in places like New York, Bost and Los Angeles.

Cooperative Research Program—FAA is ir volved in a Cooperative Research Program wit the Federal Republic of Germany. The Technic Center is a key participant in this activity alon with the MLS Program Office. The principle el ments of the activity are the DME/P and th MLS Mathematical Model. Several meetings a held annually and technical information, suc as math model requirements, are exchanged o an ongoing basis.

Avionics Development Support—Th Technical Center was involved in the enginee ing evaluations of the STEP program and u graded MLS equipment and subsystems. The are presently involved with engineering evalu tion and development work in support APM-410 in the avionics areas. Laboratori have been established to evaluate MLS receiver DME/P and MLS/RNAV equipment.

The Center will continue to provide suppo for the testing of MLS facilities. As requeste it will make facilities available to support TERF and Flight Inspection procedures developmen The technical services available at the Center a a vital part in moving through the early phas of the MLS Implementation Plan. ACT-140 w continue to test and evaluate critical proje elements of the MLS Program when problen arise as well as provide ongoing technical su port throughout the MLS implementation phas

AVIATION STANDARDS (AVS)

The AVS complex is a high level management and policy office headed by an Associate Administrator with a Deputy Associate Administrator. The Associate Administrator for Aviation Standards reports directly to the Administrator and is a member of the FAA System Acquisition Review Committee (ASARC). The AVS organization participates in the quarterly ASARC review briefing which is provided for the Administrator by the MLS Program Manager. The current status of the MLS Program is reviewed at these meetings and provisions for resolution of critical issues are established.

Functions and Responsibilities

The responsibility of AVS is to establish FAA policy and manage and direct programs for safety of flight, certification of airmen, air carriers, and aircraft, airworthiness of aircraft, aviation medicine, civil aviation and internal security.

AVS Early Involvement/ Support of MLS

Aviation Standards was involved in each step of MLS development, transition strategy and implementation. The operational requirements for a precision approach and landing system to replace ILS began in the United States and was further defined by the International Civil Aviation Organization (ICAO). The basic requirements for a new precision approach guidance system is driven by payoffs stemming from reliable and economic air transport services during inclement weather conditions. It was the view of AVS early on that any new system intended to replace ILS must, as a minimum, include the following essential features:

- High quality guidance signal that is relatively free from local terrain and structure effects.
- Provision for multiple approach paths to accommodate various classes of aircraft.
- Common system for Civil/Military use.
- Frequency band free of congestion problems.

AVS further insisted that any new program consist of ground station and airborne avionics equipment that were cost effective. It also stated that the program include assurances that affordable avionics would be available to the users during the ILS to MLS transition period itself. With these prerequisites satisfied, AVS provided its full support to the MLS Program.

The AVS organization provided support to and participated in the STEP program. This program extended the scope of MLS test and evaluation work to operational field facilities. STEP provided a smooth transition from the research and development phase to the implementation/ operational phase. For the first time AVS was able to analyze and gain experience on test facilities in the field. They used these STEP facilities for operational experience in the development of the initial Flight Inspection and TERPS procedures. The broad objectives of the STEP, defined to satisfy user and FAA requirements, were:

- To demonstrate the system performance in challenging environments.
- To demonstrate the operational and economic benefits of MLS.

The need to provide improved precision approach aids to assist in the critical landing phase of flight has long been recognized by AVS. Such aids have been installed over the years to achieve safety and operational efficiency payoffs for system users. With the advent of the new MLS Program it was apparent that a critical review and assessment of precision landing system requirements to the year 2000 and beyond was required. This assessment was both in terms of new requirements and the systematic replacement and collocation of ILS with MLS. This review task and the identification of candidate sites for the 1,250 MLS facilities provided for by the KDM was and is the responsibility of AVS. The review provided draft site identification lists for the full 15-year program. These draft listings are to serve as guides when preparing the finalized lists on an annual basis through the budgetary process.

The MLS implementation strategy is based on the establishment of MLS networks of four to seven facilities. Each network is centered on a major hub airport and the satellites are selected from regional airports that have commuter airline service with the hub. The MLS implementation program will take advantage of the increased reliability of digital electronic systems together with the reduced costs of those systems to provide the capability for all-weather service at most MLS-equipped airports.

ILS/MLS Policy

The AVS and ADL organizations took the lead in arriving at the FAA's ILS/MLS policy decision which was approved by the Administrator.

In reviewing an earlier decision to truncate the ILS program in favor of establishment of MLS facilities, the agency determined that the need to revise the existing ILS/MLS policy was necessary in order to reduce the gap in availability of precision landing systems and to minimize the impact on the users during the initial period of transition to the new MLS. A careful analysis was performed of locations that presently qualify for a precision landing system. This led to the development of a complementary ILS/MLS approach, which provided a limited number of additional ILSs for selected locations based on critical aeronautical need or initial precision approach requirements. It also provided MLS for all other locations on an accelerated basis. Additionally, most of the remaining tube-type ILS components will be replaced with solid-state components.

The selected approach is responsive to industry concerns in that critical aeronautical needs and initial precision approach requirements are satisfied with minimum impact to the users, including early realization of capacity benefits associated with new runways at major hub airports. Furthermore, this approach allows FAA to accommodate special requirements and emergencies in a timely manner. The limited ILS establishments do not jeopardize the MLS transition schedule. Also, the replacement of tube-type ILS components is cost-effective and permits the full implementation of FAA's '80s Maintenance Program.

The Administrator's policy statement is quoted verbatim as follows:

"a. Approve no new ILS installation projects except currently qualified locations that have no precision landing system at the airport or those locations that have both an immediate critical aeronautical need for a precision landing system and where it is economically beneficial to install an ILS. This includes new runways at major hub airports as well as critical training and runway repair requirements (i.e. closed runway is the only instrumented runway in the airport). Request for approval shall be submitted to the Administrator by the Regional Director and shall be supported by a fully documented staff study including a benefit/cost analysis.

b. Approve upgrading partial systems (Localizers/Outer Markers (LOC/OM)) to full ILS at those locations qualified and where such action would complete the only ILS at the airport.

c. Revise the priority of MLS installations in accordance with networking concept and prioritization scheme cited in MLS Transition Plan taking into account user needs.

d. Replace all remaining tube-type ILS components with solid-state component equipment except those locations which will receive an MLS prior to 1990."

Affordable MLS Avionics

A concern of AVS is the availability of affordable MLS avionics. Over the past several years the FAA has sponsored a number of programs to be certain that MLS receivers will be available in time to be used with the initial MLS ground installations. As a result, it is presently possible to buy receivers from at least two manufacturers. These are commercial grade sets and are in the $8,000 to $10,000 price range. These receivers are currently being produced in small quantities. Prices should become lower, to around the

$2,000 price range, when the equipment is mass produced.

Aviation Standards Complex in Support of MLS

Aviation Standards, along with Development and Logistics, are the two FAA organizations responsible for the majority of the MLS Program. The preponderance of AVS responsibilities fall in the procedures development and operations areas. Of six major offices within AVS, four provide major support services to the MLS Program. These offices are:

- Plans and Budget Branch
- Office of Flight Operations
- Aviation Standards National Field Office
- Rotorcraft Program Office

Plans and Budget

The Program Management Division, APR-100, has the responsibility for developing the MLS candidate site listings. APR-100 annually provides the MLS Program Manager and the regions with a candidate site listing for the upcoming budget year at least nine months prior to the budgetary call for estimates.

A review of preceding efforts shows that AVS developed a draft list of candidate MLS sites for the total 1,250 systems in 1981 following publication of the MLS Transition Plan. The list of sites followed the strategy and priorities outlined in the Transition Plan. A hub and spoke (network) concept was used which ranked large and medium hubs by annual enplanements and identified Boston, Denver and Alaska as the initial areas for implementation. The first 172 MLS locations have been identified, made a part of the Hazeltine contract, and are a matter of public record. At the time this list was developed, it was realized that changes would be required and that these changes would be made through reprogramming action. In revising the list, inputs from the user community were requested. The user inputs, for the most part, favor new rather than collocated facilities. This review and revision process, which is underway, will continue throughout the life of the program. However, the need for revisions to the annual listings should greatly diminish after the first several program years when a significant amount of MLS hardware is installed and commissioned.

Office of Flight Operations

The Office of Flight Operations (AFO) is the organization within AVS responsible for flight operations for both Air Transport and General Aviation. AFO is responsible for the development of flight procedures, technical standards and training. They also have responsibility for project development such as the Richmond MLS Demonstration Project. Most of AFO's MLS Program activities are involved in the areas stated above.

Since MLS provides new and different advantages over ILS, these advantages will prove beneficial to aircraft operators both in terms of time and money savings. Naturally, these benefits are of significant interest to AFO and require the development and implementation of new flight procedures and technical standards. Some of the apparent applications are:

- MLS has the potential to provide significant fuel and time savings for suitably equipped aircraft. Airports frequently have lengthy transition areas from the en route phase to the ILS intercept on final approach due to the wide divergence between the en route course and the runway heading. MLS can reduce these path lengths by providing positive guidance throughout an azimuth coverage up to $\pm$ 60° for this transition. A sampling of airports shows that 85 percent of the locations with runways over 8,000 feet have a potential requirement for wide-angle coverage as do 61 percent with runway lengths under 8,000 feet.
- Another benefit that can be realized is multiple glide paths. For example, two glide paths can sometimes be used at the same runway. A low glide path can be established for CTOL aircraft and a higher glide path can be established for STOL and other aircraft. The operating minimums for each glide path would be determined by the governing obstacle clearance criteria. This could allow lower landing minimums for aircraft that can use the steeper

glide path angles for clearing obstacles in the approach path. Additional high angle glide paths are also available for precision approaches by helicopters.

- At many airports the extended runway centerline is not available for the siting of the azimuth or localizer antenna and therefore requires an offset installation. With ILS, this results in an increase in landing minimums by at least 50 feet. With MLS the wide-angle proportional guidance and the DME/P information can be used to compute a straight in approach without an increase in minimums. MLS also has a growth feature to provide split azimuth antennas to solve this type of problem.

Procedures Development—The Air Transportation Division, AFO-200, plans and implements the necessary programs required to generate data for the development of MLS Flight Inspection (FI) and Terminal Instrument Procedures (TERPS) criteria, and the preparation of these procedures. Much of the field work and data gathering is done by the Aviation Standards National Field Office in Oklahoma City in direct support of AFO-200 programs.

AFO's Flight Inspection/Terminal Instrument Procedures (FI/TERPS) Program was approved by FAA in July 1982. The development of the FI/TERPS procedures for MLS is a major responsibility of AFO-200 which will continue throughout MLS Program implementation. The two types of procedures being developed are:

- Flight Inspection Procedures are developed for the testing and evaluation of new MLS ground facilities and recertification of existing facilities utilizing an airborne laboratory. This laboratory consists of an FI aircraft equipped with appropriate avionics test and calibration equipment. The procedures, when approved, will allow for the certification and commissioning of the MLS ground station.
- Terminal Instrument Procedures associated with aircraft operation are concerned with minimums, holding patterns, and criteria related to the separation of aircraft from obstacles. These are different from Air Traffic Control procedures which provide aircraft-to-aircraft separation.

A complete package for FI/TERPS develop ment support was derived and assembled b AFO-200 in late 1983. This package addresse the majority of the FI/TERPS requirements ove a three-year period (FY 84/85/86) and is geare to meet the MLS implementation requirement during that time and beyond. This documenta tion was used to develop an MLS Program Di rective with AVN who will provide the data col lection work and services required by the PD i support of AFO requirements.

Avionics Requirements—The AFO-20 organization is also involved with avionics de velopment. It monitors very closely the activitie of RTCA, ARINC and the avionics manufactur ing industry.

MLS Avionics is generally divided into thre classes of equipment: (1) general aviation, (2 mid-size and very large commuter and, (3 ARINC, top of the line equipment used by th air carriers. Standards are developed in tw ways:

- The RTCA Minimum Operational Perfor mance Standards (MOPS) process is concerne with the minimum standards for genera aviation.
- The ARINC standards are developed fo airline equipment. The ARINC specifications ar much more comprehensive and standardizes th way the system is installed in the aircraft so tha all manufacturers' equipment will be compatible using the same size boxes, same connections, etc

Actions by RTCA are progressing. MOPS ar available for the MLS angle equipment and ar being prepared for the DME/P and MLS RNAV. ARINC activity will begin soon.

An Advisory Circular applicable to Categor I MLS is being prepared by the Office of Air worthiness which spells out the procedure for ob taining a Supplemental Type Certificate (STC for the installation in aircraft of either of tw approved MLS receivers available today fror Bendix and Sperry. Additionally, the Advisor Circular will include guidelines on tuning th DME channels, required antenna patterns an certification of high angle descents (with lock ou

of angles beyond the aircraft's capability). Several STCs have been issued and several more are underway.

The AFO-200 organization must continually keep abreast of the technology and ensure that the industry keeps pace with FAA's planned MLS implementation. This is an interesting and rewarding activity and one that consumes a significant amount of time and resources. AFO-200 responsibilities extend to supporting the many MLS activities which are undertaken by organizations such as RTCA, ARINC and ICAO.

MLS Demonstrations—AFO has been tasked with the planning and implementation of an MLS demonstration at Richmond, Virginia. Commissioning for Richmond was in July 1985, five months ahead of any FAA production systems to be provided by Hazeltine. In addition, the FAA will purchase 20 to 30 receivers from U.S. avionics manufacturers (currently Bendix and Sperry) for installation in a number of different aircraft including helicopters. These aircraft will use a variety of cockpit displays and are likely to make repetitive approaches and landings at Richmond. The cost of procuring the receivers, equipping the aircraft by fixed base operators and the securing of type certification will be borne by FAA. In return, the agency will receive feedback from the users over three years indicating how many operations were conducted, how the facility performed, how the system improved their operation, etc. Eventually, the leased system will be replaced with a production Hazeltine ground system. The work is expected to be accomplished by a turnkey contractor who will buy the receivers, help select the participants, manage the receiver installations, develop the feedback process, collect and evaluate data and provide periodic progress reports.

Preliminary discussions have been held among local and regional personnel, the Richmond airport management team and state aviation officials. All are enthusiastic about the program. The program's objective is to get real world operational exposure to MLS among a wide spectrum of the aviation community.

Aviation Standards National Field Office (AVN)

The Aviation Standards National Field Office (AVN) is an arm of and field organization of the AVS complex. Most of AVN is located at the Aeronautical Center in Oklahoma City. There are subordinate Flight Inspection Field Offices (FIFOs) located in: Anchorage, Alaska; Sacramento, California; Atlanta, Georgia; Honolulu, Hawaii; Battle Creek, Michigan; Atlantic City, New Jersey; Oklahoma City, Oklahoma; Tokyo, Japan and Frankfurt, Germany. The FIFOs are responsible for national and international flight inspection services that are required by FAA for commissioning and certification of Air Navigation and Landing Facilities. AVN plays a large role in the MLS implementation in the development of procedures and the scheduling and conduct of MLS ground facility flight inspections.

In late 1983 and early 1984, AVN was aware of the major workload the MLS Program would place on them in providing support services to develop the Flight Inspection and Terminal Instrument Procedures criteria. An effort by AVN, AFO and the MLS Program Office led to the task definition and the development of a Program Directive which stated that AVN would provide an appropriate level of support to the MLS Program to accomplish work activities described in the directives and within the constraints of the stated schedule. The directive covered some 32 tasks to be completed over a three-year period. The timely completion of these tasks is critical to the MLS FI/TERPS development program and the overall MLS Implementation Plan. The Program Directive was signed by AVN and the MLS Program Office on April 24, 1984. A copy of the Program Directive is provided in the appendices.

The AVN involvement in the MLS Program centers around the Flight Inspection activity and support role in the development of TERPS.

Flight Inspection—The Flight Inspection activities needed to support the MLS Program comprise a major workload. The 750 existing ILS facilities will require the normal periodic and

special flight inspections for a decade or more. In addition, MLS facilities will be commissioned at a rate of approximately 100 per year until the 1,250 systems are installed. Each of these will require a commissioning flight inspection as well as periodic inspections thereafter. The fact that MLS provides coverage in a large volume of airspace would suggest that MLS facilities require more hours of flight inspection time per facility than ILS. However, the stability of the MLS signal and the increased reliability of modern electronic systems require fewer hours. Based on early experience with nonfederal MLS facilities, it appears that the number of flight hours required per MLS facility will be significantly less than with ILS. The program to prepare for the flight inspection of MLS facilities includes the following four tasks: equipment, standards and procedures, data base system, and training. A schedule of these activities is shown in Figure 5-2.

Equipment—An MLS flight inspection fleet of six Sabreliner aircraft is being equipped to handle MLS flight inspection work until the fleet conversion takes place. MLS receivers being used in the Sabreliners have been modified to provide special flight inspection functions. New aircraft acquired during fleet conversion will be equipped with MLS flight inspection receivers built to specifications developed by the Aviation Standards National Field Office.

Aircraft positioning information is currently being provided by radio telemetering theodolite (RTT) and by a limited MLS mode which has been incorporated into the automated flight inspection system (AFIS). A full MLS mode will be available in the upgraded AFISs, which will be delivered with new aircraft during the fleet conversion program.

Standards and Procedures—Order 8240.49, Flight Inspection of Nonfederal Microwave Landing Systems (MLS), was published in March, 1985. Order 8240.XX, currently under development, will incorporate refinements being made to criteria as a result of operational experience. Ultimately, the Flight Inspection Manual, Handbook OA P 8200.1, will be revised to include MLS criteria.

Data Base System—A computerized MLS Flight Inspection data system is being developed at Oklahoma City. The data base system is a data collection effort to develop a statistical base that can be used to establish the optimum period between routine flight inspections. For now, each MLS will be checked every 60 days after commissioning.

Training—Flight crew training has been underway since 1982 and will be an ongoing activity until all crews are trained in 1985. Additional training requirements are being developed as part of a program to satisfy the full range of implementation requirements.

Terminal Instrument Procedures (TERPS)—The TERPS Criteria Development Program is intended to acquire sufficient data for the development of criteria for instrument operations that take full advantage of the capabilities of MLS. This implies the need for standards for all operationally practical flight profiles in the approach and departure phases of flight. Because of the broad volumetric coverage of MLS and the precision of the azimuth, elevation and range guidance, this effort requires use of a wide range of aircraft and flight procedures. However, the initial program is limited to the higher priority tasks that can reasonably be accomplished in the near term with available resources. Figure 5-3 depicts the overall TERPS program schedule. Criteria for conventional takeoff and landing (CTOL) and short takeoff and landing (STOL) straight in approaches are currently available. For the balance of the schedule, the progression of milestones conforms to the evolutionary usage growth of MLS which is the driver for the specific TERPS priorities.

Data Collection—Several types of data are obtained from each test. All aircraft are tracked by a laser/radar tracker and the position data recorded on magnetic tape. Airborne data acquisition systems record parameters such as air speed, vertical descent rate, barometric altimeter, radar altimeter, heading, pitch, vertical and cross-track flight technical error, MLS azimuth, elevation, DME/P, flap position, vertical/longitudinal G-forces, and power position. A qualified flight observer provides notes regarding

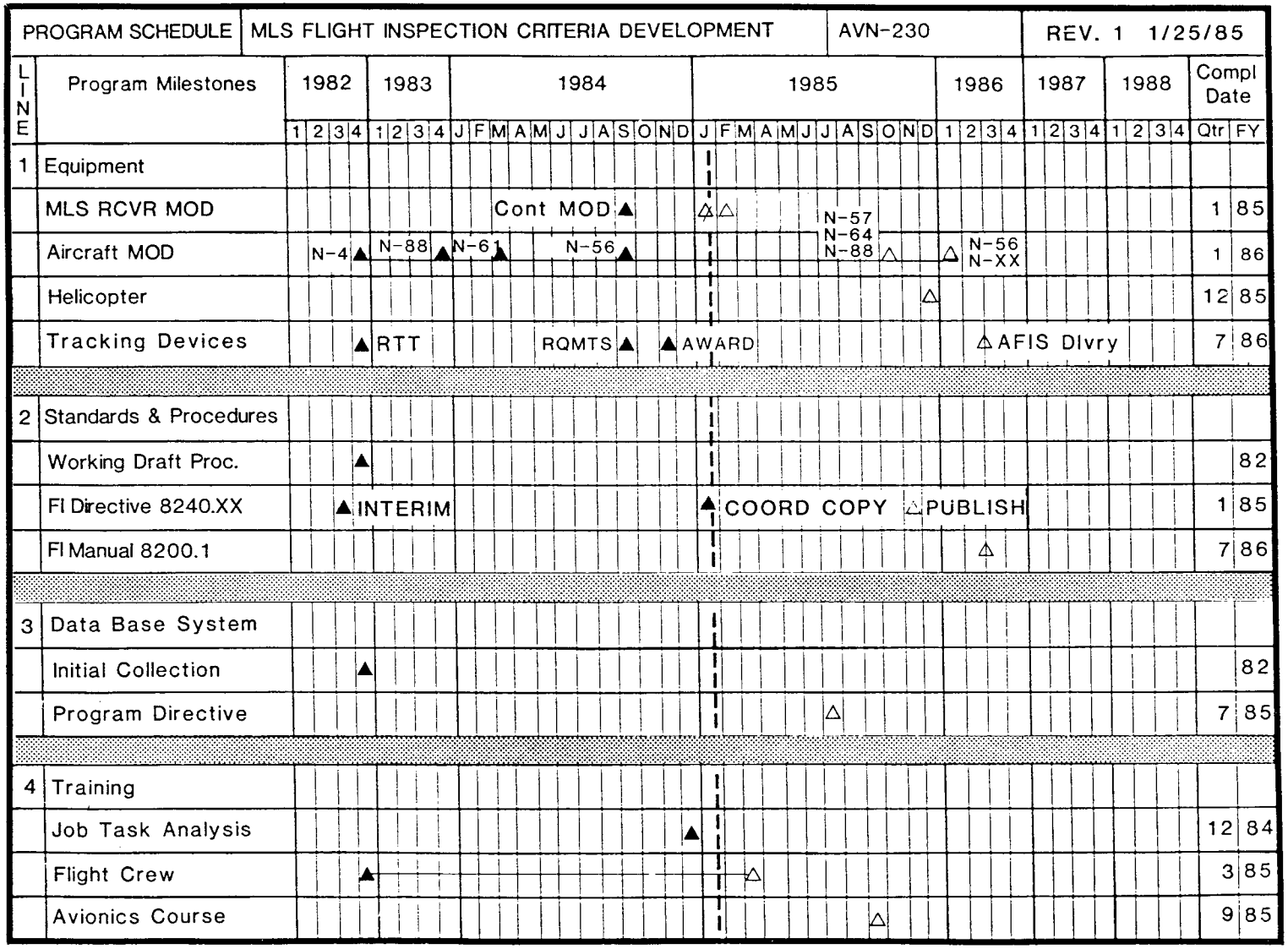


Figure 5-2: MLS Flight Inspection Criteria Development Schedule

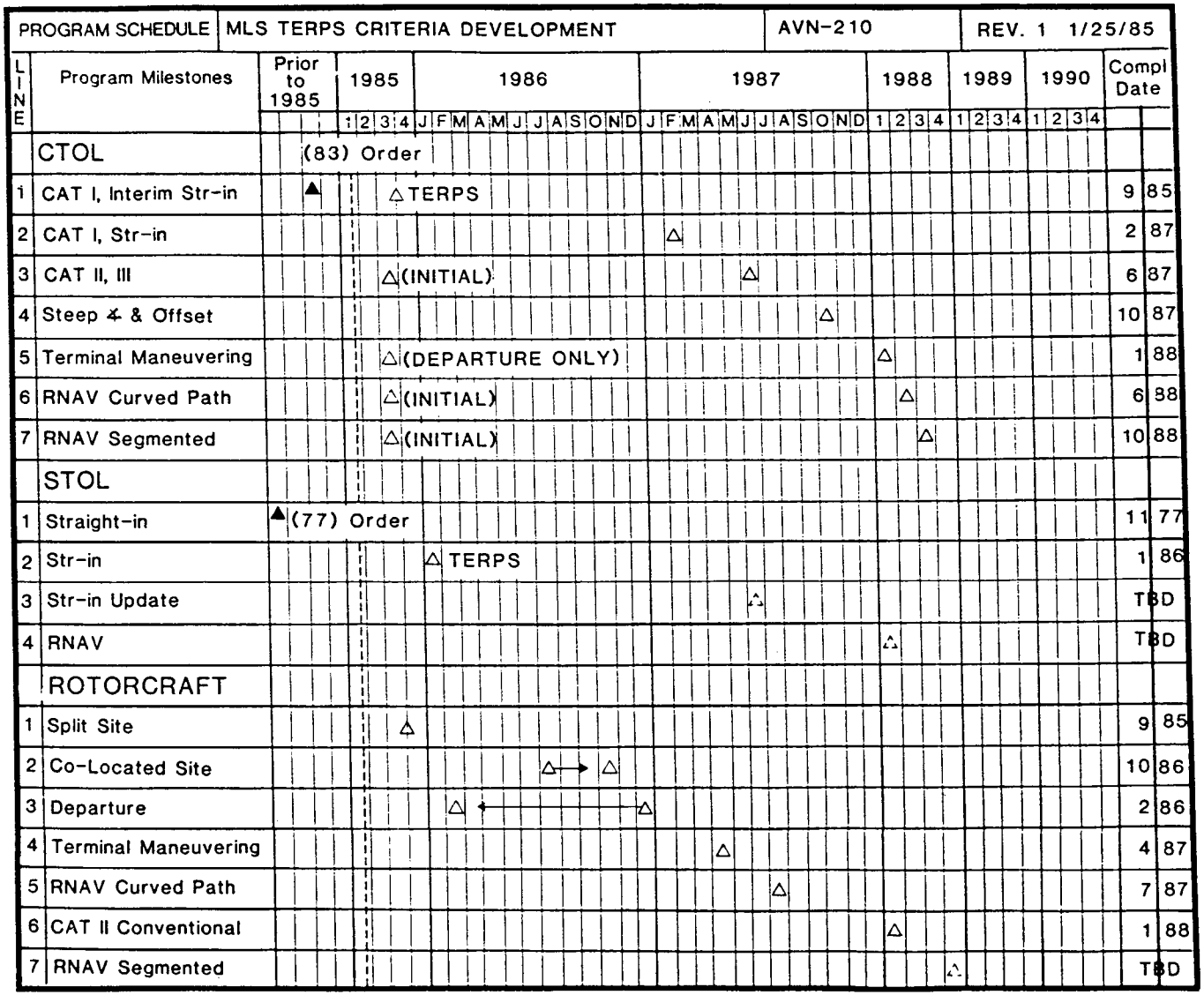


Figure 5-3: MLS TERPS Criteria Development Schedule

each flight, and all subject pilots are debriefed and asked to complete detailed questionnaires at the end of each flight.

Tracking and airborne data system tapes are time merged, data smoothed and outliers removed. Statistics are computed for total system error, flight technical error, navigation system error, height loss, and vertical/crosstrack position in the missed approach. Graphs are plotted for parameters such as airspeed, vertical descent, barometric/radar altimeter, heading, pitch, flap position, G-forces and power position.

Test Phases—Each test is composed of the following three phases:

- Phase 1: Feasibility testing. Test pilots establish what maneuvers are practical.
- Phase 2: Establishment of specific approach geometry that will be flown by subject pilots. This is typically accomplished by both test pilots and line pilots.
- Phase 3: Collection of statistical data. Specific approach geometries are flown several times by subject pilots selected from commercial, general aviation, and military operations. This data is used to develop the statistical results.

TERPS Schedule—The schedule for preparing TERPS (Figure 5-3) conforms to the expected operational requirements for procedures which is expected to begin with a need for simple straight in approaches and only gradually lead to more sophisticated requirements including segmented and curved approaches. Seven different CTOL aircraft are involved in the data collection program including the Boeing -737 and -727, Convair 550, Sabre 80, Cessna 172, Beach 200 and USAF C-141. A De-Havilland is planned for STOL work. The rotorcraft program will be accommodated by a NASA UH-1H and an FAA S76 helicopter.

Rotorcraft Program Office

The Rotorcraft Program Office, ARO, is responsible for providing management, guidance, oversight, and coordination to all agency rotorcraft programs and activities, and with managing the FAA's Rotorcraft Master Plan. This plan is an FAA-wide, 20-year plan to address the needs of the rotorcraft industry and the potential benefits to the public. The Master Plan has three main thrusts: (1) integration of helicopters into the NAS, (2) heliport development, and (3) certification improvements.

The rotorcraft industry is growing in terms of numbers of small and medium size helicopters, particularly those that are IFR certificated. In addition, during the past 20 years there has been a significant increase in the number of instrument rated helicopter pilots. There are about 4,000 heliports in the United States, only about 400 of which are public use facilities and none are IFR equipped.

Rotorcraft Master Plan—As a part of the FAA's Rotorcraft Master Plan, the All-Weather Heliport Development and Demonstration Program was initiated in the fall of 1983. This effort provides for the establishment by 1988 of four facilities with full IFR precision approach capability (installation of MLS and AWOS) and all-weather heliport criteria. These locations, which include New York City (Wall Street), New Orleans, Indianapolis and Los Angeles, will be the first heliport facilities to receive the Microwave Landing System and the Automated Weather Observation System. The FAA anticipates that about 25 similar locations will be similarly equipped during the next 25 years.

The four prototype locations are each unique in their geographic characteristics, status, and contributions to the national program. A brief synopsis of the four sites follows:

- Indianapolis, Indiana — The Downtown Indianapolis Heliport was dedicated on May 9, 1985, as a VFR facility and was the first of the prototype heliports to become operational. It is located on a 5.5-acre track of land immediately adjacent to the city's central business district.
- Los Angeles — The second largest population concentration in the country, Los Angeles represents a six-county geographic area with no public use heliport to serve the metropolitan area. The site proposed for heliport development is the downtown property of the Union Station

Passenger Terminal which consists of more than five acres.

- New Orleans — The heliport site is 6.2 acres and is located west of the Union Passenger Terminal on Julia Street adjacent to the Super Dome and the Central Business District. The growth of aviation in the area has been dramatically influenced by the rapid development of the helicopter and growth of the rotorcraft industry. Helicopters serve the off-shore oil and gas industries using Louisiana and East Texas as primary bases of operations. The Gulf Coast helicopter industry is the largest in the world, operating over 600 helicopters.
- New York — The Downtown Manhattan (Wall Street) heliport will be built and operated by the Port Authority of New York and New Jersey. It will be on a site that is located just above the Battery Park at the foot of Coenties Slip on Pier 6. It is convenient to the major air traffic generating centers of the Downtown Manhattan (Wall Street) area. It provides for convenient and fast service to and from Newark International, LaGuardia and John F. Kennedy International airports.

It is apparent from these four sites, which typify those to follow, why an all-weather helicopter landing capability is necessary and essential. To support the Helicopter Development and Demonstration Program, the MLS Program Office identified equipment in the first MLS ground station production contract.

Rotorcraft MLS Demonstration—An MLS ground station was leased early in 1985 from Hazeltine and installed at the New York heliport for analysis and to obtain operational test data. The Helicopter Program Officer, APM-720, is managing a project at the Technical Center to test and evaluate helicopter operations and procedures utilizing MLS. Rotorcraft MLS procedures and criteria are being developed over the next three years as a part of AVN FI/TERPS development program. All of these activities are in support of the ARO Demonstration Program. Once this phase is completed, the follow on activities may generate a requirement for a significant number of MLSs to support all-weather heliport operations at existing or new heliports which qualify.

Air Traffic (AAT)

The responsibility of Air Traffic (AAT) is th operation of the Air Traffic Control Systen within the NAS. This organization is headed b an Associate Administrator who reports directl to the FAA Administrator. The Air Traffic Or ganization is comprised of two services: Ai Traffic Operations Service, ATO, and the Ai Traffic Plans and Requirements Service, ATR The Air Traffic organization includes the re gional ATC Divisions and all the operating fiel facilities. The AAT organization operates on centralized management concept.

Functions and Responsibilities

The Air Traffic Organization is responsible fc the direction of programs for air traffic contro airspace allocation and use, rules, regulation and procedures, and civil/military ATC system compatibility; operational control and technic control of the ATC system; and line authorit for day-to-day systems operations.

The principle task of AAT in the MLS impl mentation process is to develop and employ th necessary ATC procedures at the time of com missioning, ensure that ATC personnel ar trained and familiar with MLS techniques, an to control the operation of aircraft in the term nal environment utilizing MLS.

The first federal MLS installations will begi in 1986 with commissionings scheduled for 198 The improved siting characteristics and signa quality of MLS will provide immediate benefit Other MLS advantages, however, are opera tional in nature and require that certain pro cedures be developed in order to realize the potential improvements over present IL operations.

The Microwave Landing System (MLS) offe advantages and flexibility not available to th Air Traffic System in the past. For example, an basic MLS ground installation will have the ir herent signal quality to support CAT I, II, c III operations. Also, the broad volumetric co erage provides the capability to support not onl straight in approaches, but also offset, curvec

and segmented approaches and precision departures (together with glide path information) throughout the airspace where signal coverage is provided. In view of these new approach and departure possibilities, it is essential that ATC procedures be available for the first MLS facilities which take maximum advantage of MLS potential. To fulfill this need, an ATC Procedures Development Program was initiated.

Air Traffic Procedures Development

The Air Traffic Procedures Development Program consists of two projects: the Facility Analysis Project and the Procedures Analysis Project.

These projects run simultaneously and are integrated at various points to produce a Facility Analysis Guide and the MLS air traffic control procedures to be published in FAA Handbook 7110.65, Air Traffic Control. In addition, these projects are designed to develop and test an analysis process and the control procedures required to take advantage of the unique operations possible with MLS.

The Facility Analysis Project

The objective of the Facility Analysis Project is to develop, through an analysis experience, a planning document that identifies a systematic process which can be applied to airport/heliport scenarios to determine the probable effect and plan for the use of the unique capabilities of MLS. This document referred to as the Air Traffic Control Facility Analysis Program for the Microwave Landing System will be issued to facility managers and serve as an aid in planning for future use of MLS.

In preparation for the analysis, personnel with both air traffic controller and procedural planning experience were selected from regional and field offices to attend a three-day orientation briefing on the capabilities of MLS. Personnel trained in the capabilities of MLS were then selected to participate in the facility analysis process.

The Facility Analysis Guide was developed while doing an actual on-site analysis at Burbank, California and the New York City metroplex with particular emphasis on the use of the

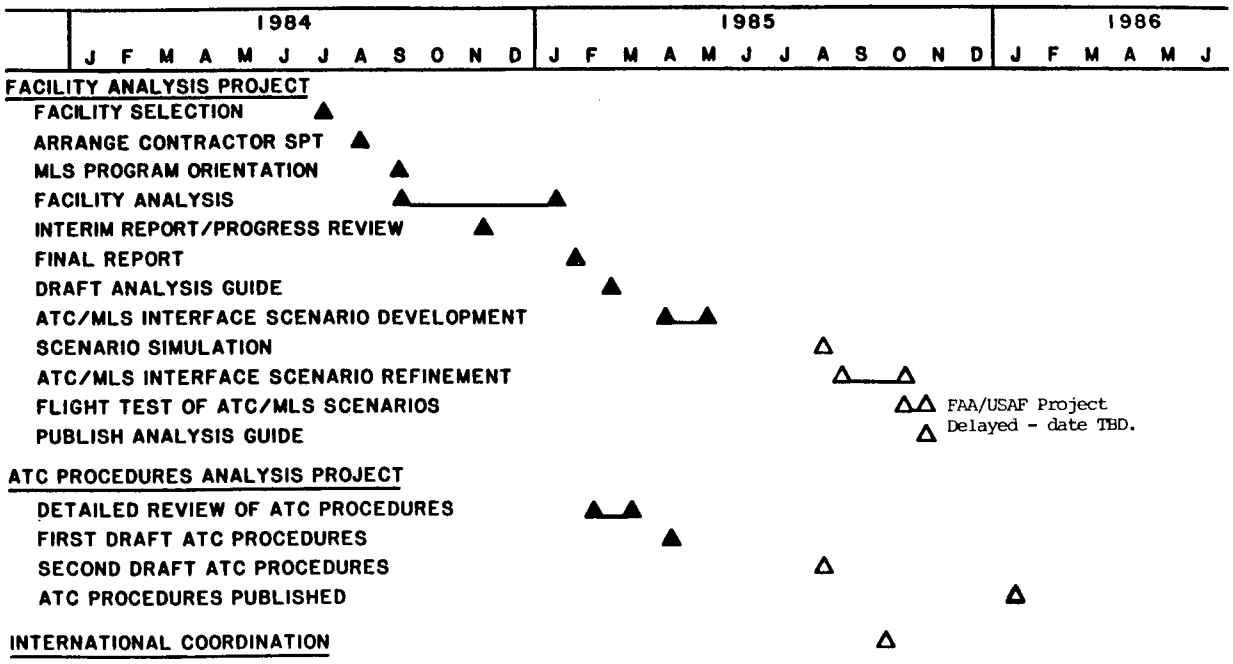


Figure 5-4: MLS Air Traffic Procedures Development Schedule

advanced capabilities of MLS to enhance traffic management efficiency and acceptance rates.

These facilities were selected based on previous studies which indicated there were several opportunities for more effective use of airspace and operational improvements.

Each of the airports are procedurally constrained either by airspace limitations (New York) or terrain (Burbank). The complexity of the traffic flows in the New York terminal area and the abundance of mountainous geography in the Burbank area made these sites excellent examples of the numerous air traffic constraints which should be addressed during the analysis process. The process of the analysis was observed, recorded, and, itself, analyzed in order to develop guidance which can be applied to other locations. This method recorded experiences for other managers so that lessons and problem areas do not have to be relearned as MLS is commissioned at each facility.

The resulting products from these on-site facility analyses were a draft analysis guide and a list of operational areas requiring additional air traffic control procedural development to support the unique capabilities of MLS.

Currently, the Facility Analysis Guide is being circulated for comments. Feedback resulting from use of this guide will be used to improve the content and/or structure. Based on the comments received, the guide will be refined, published and distributed to air traffic facility managers for application at all ATC facilities anticipating the installation of MLS.

During the Facility Analysis Project, the need for new or revised procedures was clarified. In order to write these procedures in a timely manner, the Procedures Analysis Project portion of the Air Traffic MLS Procedures Development Program was established.

The Procedures Analysis Project

The objective of the Procedures Analysis Project is to determine the requirement for procedures and develop procedures which will be issued by air traffic control personnel at airports/heliports which are equipped with MLS. The essence of this project is a detailed review of existing procedures and writing of additional procedures to meet the requirements surfaced in the Facility Analysis Project and the capabilities and anticipated uses of MLS.

The Procedures Analysis Project consisted of two comprehensive reviews of FAA Handbooks 7110.65 and 7210.3. The first review was completed in September 1983 and the necessary interim MLS procedures were established on October 25, 1983, for Category I, Straight-In, MLS approaches. The second review was conducted in March 1984 by a formal workshop of headquarters and regional air traffic specialists who conducted a detailed review of FAA Handbook 7110.65D, Air Traffic Control, Handbook 7210.3, Facility Operation and Administration, and the Airman's Information Manual from an MLS integration perspective. This workshop culminated in the identification of additional procedural needs and the development of 105 specific recommendations for change to air traffic control procedures.

The resulting products have been divided into near term procedures and procedures contingent upon the availability of avionics and TERPS data to support certain applications of unique MLS procedures. Release of these procedures will be driven by the requirement from the field.

During the Procedures Analysis Workshop, it was determined that present ILS procedures will not require any significant change to be used with straight-in MLS approaches. These procedures have been reviewed and adapted to MLS application with only minor editorial changes required.

The overall objective of the AT MLS Procedures Development Program is to provide the controller with those procedures necessary to support most MLS operations no later than January 1986.

AAT/APM Coordination Requirements

A very important area that surfaced during AT's analysis was the requirement for closer

oordination between AAT and APM in siting he MLS. The capabilities of MLS are far greater han ILS in that not only is there concern about he final approach course, but also the additional :ourses available on a ± 40° system. Air Traffic nust analyze their operational requirements and)rovide APM with the requirements for orient- ng the Azimuth and Elevation signal in a man- ıer that will best meet the needs of air traffic :ontrol and the users.

Air Traffic Training

There is a requirement within Air Traffic to 'amilarize and train Air Traffic Controllers in he utilization of MLS in the terminal environ- nent. A coordinated effort between the AAT Training Requirements Branch, ATR-710, and he APT Technical Training Branch, APT-310, s required to ensure that such training is planned 'or and scheduled to meet the requirements of MLS implementation.

The requirements for Air Traffic training have been identified and a training proposal is being drafted. Course development is to be completed in mid-1985 at which time prototype classes will be conducted. Final course development is planned for completion in the fall of 1985 when field MLS ATC training will begin.

Once the national procedure development program is complete and procedures are published, each field facility planner must examine the individual location conditions and planned procedures to ensure that the capability of a particular MLS is fully exploited and that the procedure will enhance traffic flow. Some of the factors that need to be examined are: traffic flow, runway configuration, noise problems, obstructions, etc., which will differ at each location. This task will be the responsibility of the regions and ATC terminal facility organizations. These procedures are the end result of the work program to utilize MLS in the operational environment. The utilization of the procedures then will depend on a properly staffed and trained ATC workforce.

AIRPORTS (ARP)

Airports (ARP) organization is headed by an Associate Administrator who reports directly to :he Administrator. It is a major management ınd policy organization with responsibility for FAA's national airport programs and planning. There are three major offices in the ARP com-)lex: the Office of Airport Planning and Pro- gramming, the Office of Airport Standards, and :he Metropolitan Washington Airports.

Functions and Responsibilities

The ARP organization has the responsibility 'or the direction of programs for airport plan- ıing, development, standards, certification and ;afety; and management of Washington Dulles International Airport and Washington National Airport.

ARP does not have a direct part in the FAA MLS implementation program under the Facili- ies and Equipment (F&E) Program. However, ARP is involved in the provision of MLS ground station hardware through the utilization of the Airport Improvement Program (AIP) grant funding for qualifying airports. The office most concerned with providing MLS facilities under the AIP program is the Office of Airport Planning and Programming.

Current Situations

The question today is how the AIP can best support the MLS Program in light of the large and fast moving F&E MLS Program and AIP funding constraints for nonfederal MLSs.

A key to gaining user acceptance of the MLS is to install, at qualifying locations, the necessary ground systems as rapidly as possible. Under the F&E program, some 1,250 MLSs will be installed over a 15-year period. However, most of these are scheduled to be installed in the late-1980s and beyond. Inquiries have been received from airport sponsors, where F&E installations are scheduled in later years, regarding the use of AIP funds to install MLSs at earlier dates. While

MLSs are eligible under AIP, sponsors appear reluctant to apply for Federal funds, unless the facility would eventually be considered for Federal (FAA) takeover when the location meets the Airway Planning Standard Number 1 qualifying criteria. Under present policy, unless the equipment is identical to the FAA's MLS equipment, it will not be considered for takeover.

Airport Improvement Program (AIP)

The Airport and Airway Improvement Act of 1982 is the authorizing legislation for both the AIP and F&E programs. Policies set forth in this act include the following:

- High priority should be given to installing a precision approach system for the primary runway at commercial service airports.
- Provide adequate navigational aids and airport facilities, including reliever airports and reliever heliports, for points where commercial service is provided.
- Reliever airports make an important contribution to the efficient operation of the airport and airway system, and special emphasis should be given to their development.
- Aviation facilities should be constructed and operated with due regard to minimizing current and projected noise impacts on nearby communities.

The use of APS 1 criteria for MLS under AIP can result in programming decisions that appear to be inconsistent. For example, $3 million could be programmed to pave a runway based upon FAA's assessment of need, yet a request for $300,000 to install an MLS on that same runway (which would improve its utility) could be denied because the quantitative criteria in APS 1 is not met. APS 1 criteria is weighed heavily in favor of scheduled passenger service. Consequently, it is very difficult for an airport such as a reliever to qualify. This is counter productive to the agency's stance on relievers, i.e., provide an attractive alternative to the primary airport.

The availability and location of MLS ground systems will largely hinge on FAA actions and policies. At present, FAA will consider taking over a nonfederal MLS if, among other things, it meets APS 1 criteria and its equipment is iden tical to MLS equipment purchased by the FAA The policy is currently under review within FAA

The success of getting users to equip their air craft with MLS receivers will be affected by th number of locations included in the networ where MLS will be the only precision approac aid. It is probably fair to assume that the vas majority of the target population for MLS re ceivers already have ILS equipped aircraft. If th majority of the locations in the network hav both an MLS and ILS, probably most users wil not equip their aircraft with MLS avionics unles there is some substantial benefit to be gaine (e.g., lower minimums from the MLS approach) The benefit from the reduction of aircraft nois impact will be minimal until curved approac or segmented procedures are approved. Seg mented approach paths will be very useful in re ducing aircraft noise and it is probable that seg mented approach procedures will be approve far sooner than curved paths. Some advantag in the reduction of aircraft noise may result fron departure guidance to be available from the bac azimuth plus DME/P which would be availabl at the major airports where aircraft noise prob lems arise. Until that time, noise relief from ML will be limited to that provided by higher ap proach angles.

The criteria used for the establishment o ILSs, like the MLS criteria, was also weighe heavily in favor of scheduled passenger service Consequently, the benefit-to-cost ratio is onl one factor although a substantial one in identi fying locations within the network. Not tying th AIP criteria to APS 1 will overcome the forego ing problem. However, some type of criteri would need to be adopted for the AIP. No on knows what the demand for MLSs will be if thi policy is adopted.

A major factor in this regard would be th FAA's position on takeover. Under the AIP, th ground system would have to be purchased un der a competitive procurement. It is expecte that the two unsuccessful companies that sub mitted proposals for the FAA contract alon with the company that received the award woul

:ompete for each grant procurement. Conse-
quently, there is no assurance that an airport
:ould receive equipment under the grant pro-
;ram that would meet the FAA's current policy
)n takeovers. The general feeling is that when
'aced with this situation, a sponsor will not re-
quest AIP funds for an MLS.

:AA MLS Policy Modification

There are recommendations by ARP that the
)resent APS 1 policy be modified for consider-
ng MLS under the AIP. When these recommen-
lations are approved, they will provide for the
ıdoption of criteria as follows:

At a reliever or commercial service airport
vith priority given to:

- Locations with major construction (new,
:xtension, or rehabilitation) on primary runway.
- To a reliever, when the associated primary
ıirport is equipped with an MLS.
- To essential service locations if the airline
erving the location makes a commitment to ac-
quire the necessary avionics.
- Locations that have noise compatibility
)roblems when MLS will reduce noise impact.
- Locations that will alleviate regional area
:apacity problems.

At locations included in a network submitted
)y a state.

The state interested in the application would
ubmit a plan for a state MLS network under
he AIP. Under this concept, a state would be
ıble to submit a proposed MLS network to the
'AA for consideration for AIP funding. The
'ollowing would be a part of the submission:

- The state would be expected to include
ustification for any airport included in the net-
vork that is not a reliever or commercial service.
- The state would have to agree to act as a
o-sponsor. This would allow a multi-facility lo-
ation procurement rather than an individual air-
)ort procurement.
- The state would be expected to include a
naintenance plan. (Note: The equipment neces-
sary for remote maintenance of the MLS would
be eligible.)

The FAA would have to review the proposed state system plan to assure that it dovetailed with the F&E implementation program. As part of this review, FAA would identify locations in the state network for which AIP funding would be provided. Not all locations would be funded in one year because it would be necessary to obtain at the outset a commitment from the FAA Administrator and Secretary of Transportation for funding future year locations. States would be able to use one procurement to acquire all equipment with delivery spread throughout the grant funding period. The one procurement concept would allow the state to have the same manufacturer's equipment throughout its network, thereby, reducing maintenance and training costs.

Before adopting the above criteria, however, it must be fully coordinated within FAA and concurred with by MLS implementing organizations such as ADL, APM, AVS and APO. It would then have to be published in the Federal Register to allow the aviation community to comment on it. Also, the policy of Federal takeover must be resolved since this undoubtedly will have a major impact on a sponsor's decision to seek AIP MLS funds.

The resolution of these two troublesome areas (APS 1 criteria modification and FAA takeover policy) are high on the agenda for the Airports organization and the MLS Program Office. There appears to be solutions which will allow the AIP to play a meaningful role in accelerating and supporting the U.S. MLS implementation program. With the resolution of these obstacles, needed equipment to support MLS networking can be provided to airports and heliports above those presently qualifying under the F&E MLS program.

FAA Nonfederal Facilities

Federal Air Regulations, Part 171, establishes minimum standards and procedures for the approval, installation, operation and maintenance

of navigation facilities that are not operated and maintained by the FAA, or other Federal Agencies. An amendment of this rule, covering the standards and procedures for the Microwave Landing System, was published in December 1981. Since that date, manufacturers have had the authority to produce MLS equipment for nonfederal governments, such as states, and for commercial interests. Thus far, nonfederal MLS equipment has been installed at several locations.

Valdez, Alaska

In October of 1982, the first MLS facility was established under this rule. It was also the first operationally commissioned MLS at any location. Installed at Valdez, Alaska, the facility was used to support flights of the De-Havilland Dash-7 STOL aircraft between Anchorage and Valdez. Valdez can be used as an example of a new requirement for service that could not be accomplished by ILS. Valdez is in a very mountainous area with many flight restrictions. On one side of the final approach the MLS signal coverage had to be narrowed to less than the full 40° of coverage. This was done to exclude signal coverage over the ridge and hills on that side of the airport. Also, the glide path angle was se at 6.2° because of obstructions on the approach rather than the normal 3° used for conventiona aircraft. ERA helicopters are certified users a this location. The picture of the airport at Valde shows the application of MLS at airports wit severe surrounding terrain obstructions.

Michigan State Program

The state of Michigan has a planned nonfed eral Program to install systems at Cadillac Sturgis, and Bellaire. The system at Cadillac wa commissioned in August 1984. Sturgis ha cleared all obstructions in the approach zone an will furnish regional authorities the needed in formation for FAA airspace and procedures ap proval. The region has reported that about seve months is normally required to commission facility following receipt of all required informa tion from the sponsor. This indicates that com missioning may not be before the spring of 198 Bellaire received its ground system from Haze tine in June 1985 and all approach zone obstruc tions have been removed. This system may nc be commissioned before the end of the year.

Airport at Valdez, Alaska

Houston, Texas

A nonfederal MLS was also commissioned in :arly 1985 at Houston West Airport, Texas.

The Nonfederal Program is an excellent nethod for airport operators and users to ob- ain MLS service to fulfill landing system re- quirements that must be met immediately. As a possible means of encouraging nonfederal agencies to take fuller advantage of FAR, Part 171, the FAA is considering criteria under which such facilities could receive AIP funding and eventually be taken over by the FAA for opera- ion and maintenance.

Airport Utilization and Runway Capacity

The provision of MLS under AIP is only a very small part of the overall FAA Airport Pro- gram. However, the addition of MLS at airports hould increase their utilization and runway ca- pacity. To that end, FAA has examined concepts o increase airport capacity, such as the use of hort runways, higher angle glide paths, converg- ng runways and triple parallel runways. ILS was ible to satisfy only some of the navigation re- quirements identified. MLS satisfies the full ange and, in addition, adds flexibility due to the wide-angle coverage and multiple glide path capabilities.

Applications for separate short runways have been found at several of the top air carrier air- ports. At some of these locations, MLS would provide operational advantages where there is a conflict in available airspace, converging IFR approaches, and triple parallel approaches.

The problem with independent operations on converging and triple parallel runways is sepa- rating aircraft on missed approaches. The back course of the MLS can provide the precision guidance to help assure that separation. Preci- sion azimuth and DME guidance is available to the pilot on the same instruments as front course guidance. Thus, the pilot workload in flying the back course is minimized and the precision of the missed approach increased. There are a number of airports where independent converg- ing approaches may be implemented and several that could support triple parallel approaches.

Also, the use of MLS for navigation in an au- tomated ATC system can reduce the time disper- sions at the final approach gate leading to in- creases in runway capacity and the potential for using fixed path profiles in terminal areas. The fixed path concept in turn should provide other benefits such as reduced pilot and controller workload.

POLICY AND INTERNATIONAL AVIATION (API)

The Policy and International Aviation organi- ation, API, is headed by an Associate Admin- trator who reports directly to the Administrator nd has the responsibility for developing, coor- inating and establishing policy for the agency.

Functions and Responsibilities

The API complex has a wide range of func- ons and responsibilities which deal with almost very facet of MLS activity. Its role extends from valuation and review to policy and planning and sues involving the environment and energy. It lso has the role of managing and directing the international activities and developing policy as it relates to international affairs.

API Complex in Support of MLS

There is a staff support function and four or- ganizations within API that have a support role in the MLS implementation process:

- System Acquisition Management Review and Evaluation Staff
- Office of Aviation Policy and Plans
- Office of International Aviation
- Office of Environment and Energy
- Europe, Africa, and Middle East Office

System Acquisition Management Review and Evaluation Staff

The System Acquisition Management Review and Evaluation Staff, API-20, has the responsibility to monitor, review and evaluate all the DMSA programs of FAA. There is a continuing relationship in this regard between API-20 and the MLS Program. It is the job of API-20 to keep top agency and DOT management informed on the status and condition of all existing DMSA programs. It is responsible for the scheduling and oversight of the content and formatting of the ASARC quarterly reviews for the Administrator and other high level FAA and DOT management officials. Its function is a key one in keeping FAA management apprised of the well being and status of the many elements of each program involved in the System Acquisition Management (SAM) process.

The SAM process is a complex and important part of any major FAA acquisition program. FAA initiated the SAM process in March of 1977. This established the management framework and procedures to be used in the agency's acquisition of major systems. The process provides for executive involvement at critical points and specifies the documentation required to support management action. A key decision to be made at a critical point in the MLS Program was the transition from development to implementation. An MLS Transition Plan was developed and subjected to numerous reviews which was followed by the KDM to proceed with MLS implementation.

Office of Aviation Policy and Plans

The Office of Aviation Policy and Plans, APO, is an organization with broad policy and planning responsibilities for the FAA. Its involvement with the MLS Program relates to support of the regions in providing information which will assist them in preparing their annual budgetary call for estimates. It is also responsible for the revision and maintenance of the APS 1.

APO was tasked with the responsibility of developing and issuing an MLS Transition Plan (APO-81-1, July 81). The MLS transition plar was the first one developed under the SAM pro cess. The plan and its analysis were the result of an APO managed MLS Transition Plar Working Group. This group was composed o members from 11 FAA Offices and analytica support was provided by the Transportatior System Center (TSC). The plan consisted of fou chapters: Background, Analysis of Systen Transition Strategies, Related Program Consid erations, and Public Coordination and Recom mendations. The transition plan led the way fo the development and approval of the KDM t proceed with MLS ground system acquisitio and implementation.

Ten MLS transition strategies were evaluate and are included in the transition plan. A 20-yea transition period was selected for all strategies Key options in the strategy ranged from earl MLS equippage at new qualifier airports to earl equippage at large, medium and small hubs. Ad ditional factors used in the strategies include installing initial MLSs in networks of airports collocating MLSs with problem ILS facilities and locating MLSs on noise sensitive runways

Analysis showed there is no statistically signifi cant difference in the individual strategies. Onl 10 percent difference separated the highest fron the lowest net payoff. Therefore, the plan con cluded that there is no clear-cut economic ra tionale for choosing among the MLS implemen tation strategies. Rather, the choice should b based upon operational considerations or on th special opportunities for improved precisio guidance service created by the installation o MLS equipment. Areas of ILS limitations, whic provide likely opportunities for improvemen with MLS, are identified in the plan. All avail able information supports the adoption of ML as the new precision approach landing syster for the future. Public input supported immediat MLS implementation as did the transition pla and the benefit/cost studies.

The contribution by APO in the developmer of the transition plan was an important mileston in moving from the development to the impl mentation of MLS. The strategy and concep outlined by this plan are being used today an

provide the ground rules for the 15-year MLS implementation plan. The APO organization is still actively supporting MLS implementation through support provided by their two operating divisions: Planning Analysis Division (APO-100) and System and Policy Division (APO-200).

Planning Analysis Division—The Planning Analysis Division, APO-100, maintains and operates a computer program to support Aviation Standards and the regions in determining if specific MLS sites qualify for installation based on the establishment criteria contained in APS 1. In addition to these functions, APO-100 provides for a formal coordination and liaison role with the MLS Program by providing a participant on the MLS implementation working group. This group meets regularly on a monthly basis. All-in-all, this division is very active in staying abreast of the MLS implementation and aiding it with planning and system support.

System and Policy Analysis Division—The System and Policy Analysis Division, APO-200, provides standards and criteria for planning the establishment of NAS facilities. It is also the responsible organization for the maintenance and update of Airway Planning Standard Number 1. Two categories of MLS implementation provided for by APS 1 are:

- Establishments. These occur at runways not already equipped with a precision approach and landing system (i.e., ILS).
- Replacements. An MLS would be collocated with an existing ILS and both systems would operate for several years after which the ILS would be decommissioned.

The approach presented for the selection of runways for MLS establishment follows the pattern (though not the same criteria) previously used for ILS site selection. In general a candidate list is developed by the regions using Annual Instrument Approaches (AIAs) qualifying criteria followed by a 15-year benefit/cost analysis performed in FAA headquarters. In order to survive, candidates must achieve a benefit/cost ratio greater than unity. The FAA is committed to benefit/cost based criteria for identification of locations for facility installation.

There are some areas where the present APS 1 criteria does not provide support for MLS installation due to the lack of sufficient qualifying criteria. A determination is needed to ascertain if additional criteria should be included in APS 1 to meet specific requirements that would result in additional qualifiers. One instance of this is the situation associated with the Airports AIP activity. An effort is underway within FAA to review recommended changes to APS 1 and to make such changes as may be warranted. This matter is of particular importance to the MLS Program Office, ARP and APO-100. It is an area that needs early attention and resolution.

Office of International Aviation

The Office of International Aviation, AIA, is involved in the management and direction of FAA international policies, planning, analysis, coordination and programs. AIA provides the interface and liaison between the U.S. and other countries or international aviation organizations on all FAA programs, including MLS.

AIA Interface with ICAO—The office of International Aviation has worked with ICAO since the early 1970s in the development of a new landing system. The AIA role was primarily one of supporting the U.S. position and proposals to satifsy the operational requirement. It worked very closely with ADL throughout the development phase. In 1977 and 1978, the U.S. conducted MLS demonstrations at 12 locations around the world as a means of testing the U.S. TRSB MLS in a wide range of difficult situation and environmental conditions. AIA was instrumental in making the necessary arrangement to conduct these tests. As a result of these tests, which included an extended period of evaluation and operational demonstration, the MLS TRSB technique developed and proposed by the U.S. and Australia was adopted by ICAO in 1978 for international standardization.

AIA has a continuing responsibility in supporting U.S./FAA programs at the international forum of the International Civil Aviation Organization. AIA was involved with AVS and the MLS Program Office in arranging a symposium on MLS as a separate activity, but in coordination with the Communication Divisional Meeting

in September 1985. This symposium was a result of the ICAO All-Weather Operations Panel, AWOP, 10th meeting held at Montreal in September 1984, to discuss the progress of MLS, its future implementation planning, and the ILS/MLS transition plan.

During the AWOP meeting it was apparent that the resources to organize and conduct the symposium was better suited to ICAO, but that it lacked the mandate and finances to do so. As a result, a letter was sent from ICAO to the member states requesting their support of the activity in terms of financing, organization and management. The U.S. and Canada responded positively to sponsor the symposium on a joint basis. The U.S./Canada proposal to sponsor and manage the symposium in Montreal in September 1985, was accepted. The International Office has been involved throughout the delicate planning for the symposium.

AIA Foreign Visitor Program—As the MLS implementation progresses in the U.S., the international interest in MLS will follow suit. Many foreign visitors have visited FAA to gain technical and operational knowledge on FAA's MLS implementation plan. The foreign visitor program is an important part of AIA's overall support activity. An additional area of interest to foreign states will be the FAA training initiatives required to support the MLS Program. FAA's foreign training programs are also an area that is managed by the international office. Such training is usually done on a reimbursable basis either directly with the foreign government or through the sponsorship of an international organization such as ICAO. Training provided by FAA is arranged for under the terms and conditions of specific agreements between FAA and the requesting states or organizations. FAA training efforts promote U.S. interest by acquainting foreign students with U.S. technology which enhances future potential for U.S. sales abroad.

AIA Interface with IDCA—The role of AIA also includes working with the constituent elements of the U.S. International Development Cooperation Agency (IDCA). IDCA provides the potential for funding aviation assistance to foreign governments and the opportunity for the sale of U.S. equipment. Since MLS is a new system and one that has primarily been developed and is being implemented by the U.S./FAA, it should fare well in the international market. As an additional benefit, the MLS ground system can be provided at an affordable cost to developing nations. Also, MLS operational capabilities can be assured at locations which would have proved troublesome or impossible for the installation and commissioning of ILS equipment. Another advantage is that MLS can be installed and commissioned within seven to ten days after the site location construction activities are complete.

AIA International Meeting Support—The International Aviation Office is also the lead office of FAA for all ICAO or other foreign meetings such as the Director General of Civil Aviation Conferences and others. The subject of MLS is currently in the forefront in the international aviation community. AIA is responsible for ensuring that all necessary U.S. position papers vital to U.S. interest are prepared and submitted. This will be particularly true with MLS and its worldwide implementation during the next 15 years.

AIA Operating Divisions—From an organizational standpoint AIA has two operating divisions: the International Planning and Analysis Division, AIA-100, and the International Assistance Division, AIA-200.

- AIA-100 is responsible for international strategic planning, policy analysis and policy coordination. Matters which pertain to MLS are coordinated with ADL, AVS and the MLS Program Office. The MLS symposium is an activity which falls under the responsibility and management of this division.
- AIA-200 has the management responsibilities for all of FAA's international assistance projects and international support activities. Many of these activities fall into the category of reimbursable projects. AIA-200 is responsible for negotiating and establishing Memorandum of Agreement (MOA) with domestic and foreign entities for the provision of equipment or services by FAA to foreign recipients. Examples of

the kinds of foreign assistance projects involved are:

— Flight Inspection Services
— Logistics Support
— Training
— In-Country Civil Aviation Assistance Groups (CAAGs)
— Foreign NAS and Techncial Studies
— Technical Experts
— Equipment Leases

AIA does not usually provide this assistance itself, but normally provides for the coordination, negotiations of the agreements, and the high level management of the particular activities. The actual conduct of the activities is turned over to the organizations with the expertise, personnel and equipment to perform the required tasks. With the planned worldwide implementation of MLS over the next 15 years, there should be a significant amount of international assistance required to support the U.S. interest and international requirements for MLS ground facilities and the operational avionics system.

MLS is only a small part of the overall operations and activities of AIA. However, MLS is a program which will attract significant national and international attention during the early phases of U.S. implementation. AIA can and will play an important role in supporting the FAA and international interests during the transition period and implementation of MLS on a worldwide basis.

Office of Environment and Energy

The Office of Environment and Energy (AEE) does not have a direct role in the MLS implementation process. However, the MLS Program Office will seek guidance from AEE on all issues related to environment and energy policy. One of the principle areas is that of noise abatement. MLS, with its potential for high angle or multiple glide paths and the application of curved and segmented approaches at certain locations, may provide significant contributions to noise abatement programs. MLS also has the potential to provide significant fuel and time savings for suitably equipped aircraft. In essence, the implementation of MLS should prove to be a useful tool for developing noise abatement procedures, improving air quality and generating energy savings regarding aircraft operations.

Environmental and Energy Concerns—Environmental and energy concerns were reviewed and assessed during the planning for MLS implementation. At the present time, no serious environmental or energy related objections to the overall program are known or anticipated. However, each individual MLS installation will be reviewed for environmental and energy impact on a site-by-site basis.

The impact of MLS equipment will be considerably less than the impact of the overall airport complex where the equipment is installed. MLS siting at existing airports implies that unavoidable adverse effects caused by other airport facilities and air traffic will continue and presumably increase. Therefore, MLS installations at airports where noise or air quality problems exist should be designed to improve the existing situations or, where improvement is not possible, to minimize any additional impact. Specific areas in which MLS equipment may affect environmental quality include noise emissions, fuel and exhaust emissions, electronic emissions, radiation effects, construction, siting and energy usage.

Noise Emissions — Environmental control equipment and MLS electronics are the components of the MLS site that may emit relatively high levels of noise during their operation. In addition, installation of MLS equipment may affect both the amount and location of noise caused by air traffic.

● Environmental Control Equipment and System Electronics. An air conditioning or ventilating system may be installed in buildings housing electronic guidance equipment. The noise generated by this equipment and MLS electronics must not exceed permissible levels as defined in specification FAA-G-2100/1b, Electronic Equipment General Requirements, Part I, Basic Requirements for all Equipment.

● Air Traffic. Installation of an MLS which replaces an ILS or where no precision landing

system had previously existed will affect air traffic patterns. Because of MLS capabilities for curved or segmented approach paths, air traffic noise can be relocated from areas where low-level approach flight is objectionable (e.g., residential areas) to other areas where it would have less impact. At runways where no precision landing system previously existed, use of an MLS-equipped runway may increase noise complaints during inclement weather. This could result in an increase in air traffic in the airport's vicinity; therefore, noise analyses should be performed using the guidelines and procedures for the latest edition of Order 1050.1, Policies and Procedures For Considering Environmental Impacts. The analysis should include information about present noise conditions and should forecast conditions with and without the proposed change.

Fuel and Exhaust Emissions — MLS has an indirect effect on exhaust emissions from aircraft during approach and landing. Redistribution of air traffic and rerouting of approach paths may cause changes in air pollution patterns.

Electronic Emissions — Electronic signals from MLS could affect electronic devices that do not have adequate electronic filtering to eliminate the assigned MLS frequency. Such interference problems will be included in the site-specific environmental impact statement.

Radiation Effects — Human exposure to MLS microwave radiation will not be a hazard as such radiation is well within the standards of ANSI C95.1-1974 for maximum continuous human exposure. Additional studies demonstrating that MLS equipment does not pose a hazard to human health were conducted by the National Bureau of Standards.

Construction — The impacts associated with MLS construction are limited and short term in nature. Site construction includes the use of power-operated excavation equipment and vehicles that will produce minor fossil fuel emissions. Construction activity is normally limited to removal of topsoil to adjacent land surfaces, surfacing of the plot area with gravel sterilized to prevent weed growth, excavation for the construction of piers for support of the building and light structures, and grading and gravel surfacing of the access roadways. Normal construction safeguards to minimize erosion will be used.

Siting — The establishment of certain MLS components may require procurement of additional property. In such instances, the procurement and siting must be reviewed in accordance with Order 1050.1. Impacts on community continuity and land use compatibility should be reviewed. In addition to the National Environmental Protection Act, other federal laws and directives require consideration for environmental and other effects of various actions taken by the agency.

Energy Usage — The energy requirements of MLS equipment are expected to be comparable to those of the existing ILS. MLS installation at airports where no precision landing system was previously installed is, of course, expected to increase the airport's total power consumption. Specific areas where MLS siting will affect energy usage include normal and emergency power, construction, and air traffic.

Europe/Africa/Middle East Office

The Europe, Africa and Middle East Office, AEU, is a field organization of API and is located in Brussels, Belgium. The office is responsible for liaison and cooperation with governments and civil aviation entities in its area of jurisdiction. The office also works closely with AIA in establishing, monitoring and managing technical programs and assistance being provided to foreign states. The office oversees FAA Representatives in London, Dakar, Paris and Rome. As part of the organization there is an International Field Officer (IFO) in Frankfurt, Germany, and a U.S. Administrator for Aeronautics in Berlin, Germany.

The AEU provides an on scene presence fo FAA in its geographic area of the world. In thi role, it represents all areas and interests of FA on aviation matters and policy. It is an impor tant member of Europe's aviation communit and represents FAA at regional meetings. ML is presently an item of significant interest i Europe and Africa. The AEU works directl with API and the FAA MLS Program to assis them with their planning and strategy for ML implementation in their area of the world.

ADMINISTRATION (AAD)

The Associate Administrator for Administration, AAD, reports directly to the Administrator and is responsible for the administrative policy and support functions of the FAA. The AAD organization is charged with developing and executing administrative policy and support which is essential to FAA in performing its mission and programs.

Functions and Responsibilities

The AAD complex has a wide range of functions and responsibilities dealing with providing Administrative Services for the FAA. Its role involves systems acquisition, initial provisioning and follow on supply support, budget and accounting services, and management systems.

Administration Complex in Support of MLS

There are two offices within the AAD complex that have significant roles in the MLS implementation process: Acquisition and Materiel Service, and Office of Budget.

Acquisition and Materiel Service (ALG)

The Acquisition and Materiel Service, ALG, provides a major support role in the acquisition and initial provisioning of MLS hardware and its follow on supply support. ALG is the primary office of FAA that is involved in the procurement of equipment/systems that are being procured as part of the NAS Plan. In addition, ALG is the organization within FAA responsible for formulating and developing policy and procedures for procurement and provisioning. ALG is also the office which provides the policy and guidance for the phaseout portion of a system's life cycle, to include the reuse and disposal of real and personal property.

The underlying objective of the logistics strategy for MLS implementation is to follow the concepts of the FAA '80s Maintenance Program which will improve safety through increased reliability and availability of aviation ground facilities, and reduce costs by making the maintenance functions less labor intensive. To achieve this objective, the following approaches will be pursued: (a) use of remote maintenance monitoring and high equipment reliability to achieve a goal of one site visit every 90 days, (b) use of a standard configuration having commonality of components, (c) minimizing the numbers of manufacturing designs, and (d) use of the hardware contractor to carry out an integrated logistics support program. The planning for the provision and support of the MLS equipment has been developed along these lines by ALG.

ALG has three divisions that provide direct support to the MLS Program. They are:

- Materiel Management Division
- Contracts Division
- Industrial Division

Materiel Management Division—The Materiel Management Division, ALG-200, is responsible for logistics policies and standards which include initial provisioning, follow on supply support, and inventory management. Some of the areas for which they have responsibility are:

- Provide guidance and direction to the FAA Depot for the acquisition and management of spare/repair parts in the range and quantity necessary to maintain and operate the NAS facilities and equipment.
- Ensure that sufficient spare/repair parts are funded and procured to fully support new facilities, such as MLS, at the time of procurement and for a reasonable time into the future when the equipment is in operation. Generally, replacement parts are never less expensive than at the time of initial equipment procurement.
- Develop policies and standards for spare/repair parts support to field facilities by the FAA Depot at the time of and after facility commissioning.
- Provide guidance and coordinate with APM to ensure provisioning practices are current and in accordance with the concepts of FAA '80s Maintenance Program.
- Work closely with the Contracts Division

on all new DMSA procurement activities, such as MLS, to be certain all spare/repair parts, technical documentation, and logistics management data requirements have been considered and are a part of the procurement planning for new equipment acquisition.

- Plan the training requirements for logistics personnel at field facilities so they are prepared to support new DMSA equipment when it comes on line.
- Develop and ensure the implementation of all logistics and materiel management policies and standards for FAA.
- Provide policy, systems, and standards needed to reuse or dispose of excess property in a manner which is effective, efficient, and in compliance with governing laws and regulations.
- Provide guidance and coordinate all logistics and materiel management activities required to support the FAA's '80s Maintenance Program with the FAA Depot.
- Work with the MLS Program Office to coordinate and implement any logistics or materiel management agreements that may be necessary in the MLS implementation process.

The Materiel Management Division plays a vital and significant role in ensuring that logistic support is available at the time of facility commissioning and for its continued operation. In the case of MLS, it is particularly important due to the large number of new facilities that will be installed annually. Also, at this time there are no production MLS parts in the FAA inventory and an MLS part support system must be provided.

Contracts Division—The Contracts Division, ALG-300, is responsible for the issuance of FAA contracts which are managed and directed by the national headquarters offices in Washington. Each DMSA program has a Contracting Officer assigned for its major procurements. In the case of the MLS procurement, the Contracting Officer is assigned to the Communications/Navaid Branch of the Contracts Division. Some of the responsibilities of the Contracting Officer are:

- Work directly with the APM-410 Contracting Officer's Technical Representative (COTR).
- Prepare and provide proposed contract documentation.
- Ensure compliance with the Federal Procurement Manual, (FPM) and DOT/FAA procurement policy, regulations and procedures.
- Issue Invitations for Bids (IFB) and Requests for Proposals (RFP).
- Participate in bid and proposal evaluations.
- Issue contracts for the development and production of MLS equipment.
- Provide for contract changes and amendments.
- Interface with the equipment procurement contractors.
- Provide procurement advice and guidance to the MLS Program Office as part of the planning process for new procurement.

The Contracting Officer works very closely with APM-410 and the MLS Program Office on all matters concerning procurement and contracting for MLS ground systems and associated requirements. It is the Contracting Officer's responsibility to ensure contract administration is conducted so as to provide services, systems and equipment from contract sources that will meet MLS implementation planning schedules.

Industrial Division—The Industrial Division, ALG-400, has the responsibility to ensure adequate quality assurance standards are available and contractor performance is monitored to ensure equipment and materiels provided are in compliance with the government contract. It also provides industrial engineering services, in-plant contract administration and inspection and acceptance of equipment, materiel and systems submitted by contractors. These functions are performed by three branches: the Quality Assurance Branch, the Industrial Evaluation Branch, and the Quality Standards Branch.

Quality Assurance Branch, ALG-420 — This Branch has the responsibility to ensure the quality of the products being provided under U.S. Government/FAA contracts meets the requirements contained in the contract. Personnel of the branch are assigned to specific contracts by

a letter of delegation from the Contracting Officer. The assigned Quality and Reliability Officer (QRO) has the authority to perform the monitoring, testing, and inspection/acceptance of all items being provided under the contract. The following activities are performed by the QRO:

- Provide for inspection/acceptance of all items in accordance with contract requirements.
- Ensure contractor quality assurance activities are in accordance with contract quality requirements throughout all phases of the contract including site installation activities.
- Review and monitor contractor test plans and procedures and manufacturing operations.
- Ensure all test data is recorded and properly documented and maintained.
- Provide feedback to FAA management on contract performance.
- Perform other contract administrative functions such as reviewing and verifying progress payments.

Additionally this branch provides Industrial Specialist (I.S.) personnel. The I.S. performs overall production surveillance, status reporting and coordinates actions relating to contract modifications, engineering change proposals, waiver requests, and schedule changes.

Industrial Evaluation Branch, ALG-410 — The Industrial Engineers (I.E.) of this Branch provide the following support to the MLS program:

- Provides advice and assistance to the C.O. and T.O., from an industrial engineering viewpoint, on matters relating to industrial management, and program planning.
- Reviews and comments on procurement and technical documentation to be included in the procurement.
- Evaluates contractor's production planning and manufacturing capability.
- Evaluates quality plans for compliance with contract quality assurance requirements.

Quality Standards Branch, ALG-430 — This Branch supports the other Branches in the Division by providing the standards, guidance, and interpretation of quality assurance standards to be used in FAA procurements. In addition, the Branch provides support to the MLS program as follows:

- Provides comments on technical documents used in procurement.
- Provides Reprocurement Data Support to the Program Office.
- Provides guidance to support the Program Office on Quality Assurance during turnkey site installation.

Office of Budget

The Office of Budget, ABU, is the central office of FAA responsible for the development, submission and monitoring of the agencies budgets. This includes the R&D, F&E and Operations budgets. In the case of the MLS Program, all three of these budgets are involved.

- R&D — Provide funds for the research and development activities associated with MLS development. This area was high cost in the past, but is minimal at this time and should continue so in the future.
- F&E — Provide funds for the procurement and implementation of MLS ground system hardware. This is a high cost area at present and will remain so throughout the acquisition period.
- Operations — Provide for funds to operate and maintain MLS systems. It is relatively low at this time but will increase significantly in direct proportion to the number of MLS ground systems installed and operated.

The Budget Office is instrumental in preparing and managing the agencies budget. In doing this it must take the lead in coordinating all budgetary program matters within the national headquarters. This is the case with MLS, where a close relationship is maintained between the MLS Program Office, AVS, APM and the region in the development of the annual budget call for estimates. The MLS Program Office must provide ABU with sufficient information to obtain and if necessary defend the requirement for funds to support the MLS implementation.

The Budget Office provides advice and policy guidance to the MLS Program Office on all matters relating to the budget. They provide direct fiscal support to the MLS Program both in terms of budget year and current year requirements. A close relationship is maintained between the regions, APM-4A and ABU on all budgetary matters associated with the MLS Program. They are informed of and take appropriate action tc provide funds associated with all approved reprogramming activities. The Budget Office provides representatives to attend meetings and serve as members on working groups as may be required to support budgetary considerations which are a part of such meetings.

HUMAN RESOURCES MANAGEMENT (AHR)

The Associate Administrator for Human Resource Management, AHR, reports directly to the Administrator and is responsible for all programs dealing with human resources and employee relations. The AHR organization is charged with developing and executing FAA policy which deals with human resources and ensures that these actions are effective in providing human resource support essential to FAA in performing its mission and programs.

Functions and Responsibilities

The AHR organization has the functional responsibility of dealing with all areas of human resource management. The agency has placed a high priority on the effective management and utilization of its human resources as they are its most valuable asset. This organization has the responsibility for the direction of programs for personnel, training, human resource planning, organizational effectiveness, and labor and employee relations.

Human Resource Management Complex in Support of MLS

There are four offices within the AHR complex. These offices have an interface with the MLS program as they do with all organizational entities of the FAA. The offices within AHR are as follows:

- Office of Human Resource Planning and Evaluation, AHP.
- Office of Labor and Employee Relations, ALR.
- Office of Organizational Effectiveness, AOE.
- Office of Personnel and Technical Training, APT.

The Office of Personnel and Technical Training, APT, has the greatest direct involvement with the MLS program implementation, supporting the MLS Program by providing personnel support service and developing and arranging for MLS training programs. The two divisions in AHR most involved in the MLS Program are the Human Resource Management Division and the Technical Training Division.

Human Resource Management Division— The Human Resource Management Division, AHR-100, provides for the personnel management support services within the FAA headquarters associated with FAA programs including MLS. Some of the services in support of the MLS Program and available to the MLS Program Office are:

- Manage and maintain the Personnel Management Information System (PMIS).
- Classify positions.
- Provide career development and counseling services.
- Hire new employees.
- Produce and distribute employee training histories.

This division works closely with APM organizations on all matters pertaining to personnel requirements in the FAA headquarters that arc associated with the MLS Program. AHR-100 is a line organization and does not provide guidance or policy to the regions and other fielc organizations. The offices that have the responsibility for the planning, evaluation, and effectiveness of resource requirements are AHP anc

AOE. These organizations will provide advice and policy guidance to the regional personnel operations divisions to ensure that appropriate human resource planning is undertaken to support MLS implementation planning. This is a very important matter as the MLS personnel support requirements will have a significant impact on the regional field support organizations throughout the MLS implementation process.

Technical Training Division—The Technical Training Division, APT-300, has management responsibilities for both technical and managerial training. It must work closely with APM to identify training requirements, and to plan and program for these needs. The division must look at the overall needs for FAA training to fully support five major areas in the MLS training program. They are:

- MLS Indoctrination Training
- Maintenance Training
- Air Traffic Training
- Flight Standards Training
- Training Programs Under Development

MLS Indoctrination Training — This MLS Indoctrination Handbook is intended to be used for indoctrination training. It is designed for and directed to individuals within the aviation community (FAA and outside) who will benefit from a single description of the MLS system, exposure to the terminology unique to the system, and some general information on the program planning and its implementation. A follow on to this handbook will be two video tapes of the MLS ground systems and the operational aspects of MLS.

Maintenance Training — Maintenance Training is covered by two training options under the Hazeltine Contract. The first option provides for all of the maintenance training requirements except operational tryout and contractor conducted classes, which are included in the second option. The training provides Computer Based Instruction (CBI) hands-on training for technicians and field engineers. The first classes will be held at the FAA Academy where instructors and contractor personnel will be available for course operational checkout and student assistance.

Air Traffic Training — Requirements for Air Traffic Training have been identified and a training proposal developed. Course development is to be completed in early-1986 at which time prototype classes will be conducted. Final course development is planned for completion in mid-1986 when field ATC training will begin.

Flight Inspection Training — The Flight Inspection Training requirements have been identified and the training will be conducted for the following:

- Training for Aviation Standards and Certification Personnel (i.e., air carrier and other inspectors).
- Training for FAA Avionics Maintenance personnel.
- Training for flight inspection personnel.

The Technical Training Division has an ongoing role in the MLS Program implementation. The requirements facing APT-300 are the heaviest during the early phases of the implementation. This will slack off and become routine in about two or three years.

PUBLIC AFFAIRS (APA)

Functions and Responsibilities

The Office of Public Affairs, APA, is directly responsible for and reports to the Administrator on all matters dealing with FAA Public Affairs. The office is headed by an Assistant Administrator and is the central point within the agency for dealing with items of public interest and employee communications.

The APA organization has the lead role in coordinating and developing audio visual material in support of agency programs. This office is also responsible for public and employee communications, community and consumer liaison

and aviation education. To accomplish these tasks, APA is staffed with three operating divisions which are involved with the MLS Program. They are:

- Plans and Audio Visual Division
- Public and Employee Communications Division
- Community and Consumer Liaison Division

Public Affairs Support of MLS

The MLS Program Office maintains close coordination with the aforementioned operating divisions on all matters of public and employee interest and to obtain their support and assistance as required.

Plans and Audio Visual Division

The Plans and Audio Visual Division, APA-100, is the organization that works closely with the MLS Program Office for the preparation and use of motion pictures and video tape presentations. One MLS video tape of approximately 28 minutes has been prepared and released by the FAA for public use. This tape deals primarily with MLS benefits. The MLS Program Office is planning two additional video tapes that will provide audio visual information on the MLS ground system hardware and the operational aspects of MLS. These efforts are viewed as very important by the MLS Program Office and APA-100 to provide information and familiarization with the MLS equipment and its operation early in the program.

APA-100 also provides advice, guidance, and support to the MLS Program Office on visual material that may be used in presentations regarding MLS. This kind of assistance would also be provided for like material to be used in conjunction with articles released to trade journals, magazines or newspapers. On the other hand, the division would look to the MLS Program Office for support when it needs pictures or graphic materials to support articles or releases by APA.

The audio visual material is a very important and powerful tool in getting the MLS message across to the public and elements of FAA no specifically involved in MLS. The MLS Program Office will continue to need significant suppor from this Division over the next several years

Public and Employee Communications Division

The Public and Employee Communications Division, APA-200, supports the MLS Program by keeping interested parties informed on a timely and factual basis. While many elements of the communication process are the same, the public and employee areas will be addressed separately to provide a better understanding of their relationship to MLS Program implementation

The MLS Program Office and APA-200 must closely coordinate activities to provide appropriate releases and articles to the public. Some examples of such activitives are:

- Press releases on contract awards.
- Press releases on significant events; first MLS commissioning, establishment of a network, etc.
- Articles submitted by the MLS Program Office for trade journals or magazines.
- Speeches or formal addresses by FAA top management involving MLS matters.
- Matters of public record on MLS provided to the Congress.
- Responses to media inquiries regarding MLS.

These two offices also coordinate and cooperate on all inquires from the press and media regarding current events and status of matters relating to MLS. Another very important function of APA-200 is keeping FAA employees informed on all significant events and matters which may effect them through: (1) the FAA "Intercomm", which is published weekly in the headquarters and the regions, and (2) the monthly FAA magazine, *World*, which is published by APA for the FAA.

- The FAA "Intercomm" is an informal newsletter that allows for quick and easy input by FAA management and employees. Short articles are provided by the MLS Program Office and others to cover MLS Program events and

status for inclusion in the weekly "Intercomm." It is also a good vehicle for field personnel to provide their inputs relative to MLS implementation as they see it. Articles for the "Intercomm" are easy to prepare and usually are no longer than 10 or 15 lines. The division staff edits and formats the articles. It is a rare occasion when articles submitted are not included in the weekly editions. The "Intercomm" is distributed to all FAA offices and employees.

- The FAA *World* is a slick magazine which publishes important and interesting feature articles and photographs on FAA activities. The magazine provides an excellent vehicle for the MLS Program Office and APA-200 to tell the story of MLS. The preparation of an article for the *World* requires more planning and thought to arrive at a good product. However, the effort is worthwhile and the payoff is usually considerable. The FAA *World* is distributed to all FAA employees and retirees.

Community and Consumer Liaison Division

The Community and Consumer Liaison Division, APA-300, maintains liaison with the community and consumer groups. The MLS Program Office and APA-300 work together when MLS activities are involved.

The Public Affairs Office is also responsible for keeping and maintaining the agencies historical records and documents. The MLS Program Office is responsible for providing the necessary factual information to update MLS historical records. This is usually done on an annual basis.

OFFICE OF AVIATION SAFETY (ASF)

The Office of Aviation Safety, ASF, is headed by a Director who reports directly to the FAA Administrator. This office is the central point within the agency on all matters dealing with Aviation Safety.

Functions and Responsibilities

ASF's principle functions and areas of responsibility are:

- Safety and safety consciousness in air commerce.
- Accident and incident investigation.
- Analysis of safety trends.
- Special Safety investigations, analysis and programs.

Safety Features

While there is little direct participation by ASF in the MLS implementation, there is an occasional role of coordination and liaison. Like any major new system implementation, enhancing and improving safety is of major concern. MLS has a number of inherent characteristics that enhance safety. These safety features are related to the siting flexibility, wide-angle coverage, departure guidance, signal quality, and other new functions.

Siting Flexibility

One safety aspect is the ability to provide precision guidance at difficult sites where use of ILS is not practical or is restricted. These include sites in mountainous areas (e.g. Rocky Mountain sites), helipads, and short runways. The use of MLS allows small aircraft to land on separate short runways. The resulting separation of light and heavy aircraft into two homogenous traffic streams will enhance safety as well as improve traffic flow.

Wide-Angle Guidance

The wide-angle proportional guidance allows aircraft to acquire the MLS signal and verify that it is correct before the turn onto final approach. This wide-angle feature is also beneficial during VFR operations to preclude erroneous approaches to the wrong runway which has occurred in the past. Moreover, the wide-angle guidance allows pilots to better anticipate the

turn onto the final approach and, thus, reduce overshoots of the final approach course. The fact that the MLS is identified both by aural Morse Code and by visual display reduces the probability of acquiring the wrong ground station. The digital signals also provide identification of the runway in use.

Departure Guidance

The MLS back azimuth function, when installed, will provide precision guidance for missed approach and departure. This will increase safety.

Signal Quality

The technology inherent in MLS provides a higher degree of signal stability and increased immunity to interference compared to ILS. This will permit autopilot capture at longer ranges and reduce the dispersion in aircraft tracks, thereby increasing landing precision.

New Functions

MLS can facilitate wake vortex avoidance b allowing light aircraft trailing heavy aircraft t approach and land from a higher glide angle This provides increased protection to the ligh aircraft without changing aircraft separatio standards.

The broad applications of MLS described i this section evolve from innovative uses of ML through its capability to provide accurate three dimensional guidance for approach and landing The system also provides the flexibility for th development of new ATC procedures to achiev improvements in airport capacity and more effi cient use of the Nation's airspace. While im provements have been made to ILS which en hance its performance as a landing aid, the im proved accuracy, greater signal integrity, an wide-angle coverage of MLS provide a new leve of operational flexibility, growth capability, an safety.

AERONAUTICAL CENTER (AAC)

The Mike Monroney Aeronautical Center, AAC, is located in Oklahoma City, Oklahoma. The center is a large FAA organization with responsibility for training, depot support, and initial spare/repair parts provisioning and follow on procurement in support of the MLS Program. AAC also has other organizations such as the Civil Aeromedical Institute, Airmen and Aircraft Registry, Data Services and Administrative Systems. The Aviation Standards National Field Office, AVN, is located at the center but is not a part of that organization.

Functions and Responsibilities

This section will be limited to training conducted at the FAA Academy (AAC-900), spare parts provisioning and support by the FAA Depot (AAC-400), and procurement support by the Procurement Division (AAC-70). These functions play a very important part in the implementation of the MLS Program. Consequently, an Associate MLS Program Manager has been designated by the AAC Director. Th AAC MLS Associate Program Manager is re sponsible for keeping abreast of all AAC activi ties involving MLS and to serve as the Director' representative for interfacing with the MLS Prc gram Office. The Associate Program Manage is assigned to the FAA Depot staff.

Aeronautical Center Complex in Support of MLS

The FAA Academy, FAA Depot, and Aerc nautical Center Procurement Division support MLS as follows:

FAA Academy Training

Two significant training activities are manage by the Aeronautical Center. These are: FA Management Training School at Lawton, Ok lahoma, and the FAA Academy Training Schoc at the Aeronautical Center in Oklahoma City Oklahoma. The management training is broa

)ased management training and does not signifi-:antly involve MLS Program implementation.)n the other hand, the FAA Academy technical raining is an integral part of the MLS Program)lanning. The Academy conducts three types of Technical Training related to MLS:

- Air Traffic Control
- Airway Facilities
- Flight Standards

Technical Training Development—The FAA Academy, AAC-900, is the provider of technical raining. The requirements are levied by the MLS Program Office in coordination with APT-300. These requirements are reviewed by APT and hen training plans and programs are developed. Coordination is effected with the Academy dur-ng this phase and the Academy's input is en-:ouraged. Once a training program is approved, t is then turned over to the Academy for imple-nentation. The implementation process involves he following:

- Developing course outlines
- Developing course curriculums
- Determining Instructor Staffing
- Providing for classrooms and laboratories
- Planning for equipment from procurement contracts
- Training Instructors
- Developing or purchasing training materials
- Scheduling training classes
- Arranging for student accommodations
- Establishing instructor staff
- Providing classroom instruction

The Academy has technical experts in each of he technical areas who are knowledgeable in the ield of training. They are the cadre of experts vho develop the specific courses which are re-juired to support the training programs. When ıdditional help is needed, it may be provided by ı separate contract or, in the case of the MLS Program, maintenance training support is pro-ided as part of the MLS ground system sup-)ort contract.

Technical Training Schedules—The training)rovided by the FAA Academy must be sched-uled and provided so as to fully support the MLS implementation planning. Most of the training for the MLS Program has been identified and is now in the final programming phases. The role of the FAA Academy in support of the MLS Program is primarily one of providing technical training and seminars for FAA Engineers, Technicians, Air Traffic Controllers, Flight Standard Specialists, and Managers.

FAA Depot MLS Support

The FAA Depot, AAC-400, provides a broad base of materiel and equipment support to the NAS. Its many responsibilities include: acquisition, receipt, warehousing, and distribution/transportation of spare/repair parts, both common and peculiar, and initial establishment and replenishment of site spares; initial and follow on provisioning, inventory management and cataloging of spare/repair parts and materiel; and the overhaul modification, and repair of equipment and assemblies in-house or by contract.

The FAA Depot also has the responsibility to ensure that all NAS acquisitions include timely initial provisioning, provisioning technical documentation, and logistics management data essential to the commissioning and follow on maintenance support operations of NAS systems. For a better understanding of the FAA Depot's role, functional areas are examined separately.

Storage and Transportation Branch—The Storage and Transportation Branch, AAC-430, has the responsibility for receipt and storage of all equipment, material and spare parts at the depot. The process for receipt and storage is highly efficient and automated. The branch is also responsible for the transportation and shipment of all orders from field facilities, FAA Offices and other authorized sources. All shipments are handled through the use of automatic processing utilizing a priority based system.

Supply Management Branch—The Supply Management Branch, AAC-480, has the responsibility for initial provisioning to identify specific supply support requirements and initiate timely actions to assure availability of spare parts and materiel when needed. The maintenance concept

in existence at the time of provisioning provides the constraints and criteria within which initial provisioning determinations are made. This function is critical to the MLS process at this time as complete new inventories of parts must be established in conjunction with the delivery of the first MLS production equipment. The AAC-480 branch and the MLS program office must closely coordinate on this matter to ensure the logistics system can and will be fully responsive to MLS needs by early 1986. The supply management activities of the branch are highly automated and directly linked into the storage and transportation system as well as DLA and GSA supply systems. The branch also has the responsibility for ongoing stock replenishment through repair and acquisition processes which employ inventory management techniques. To ensure that spare parts and materiel are available and on hand in sufficient quantitities, inventory managers are assigned to oversee the status of each of the thousands of items in the Depot inventory. The inventory manager maintains total control over assigned items. This includes issue of an item and initiation of acquisition, repair or repair and return (R&R) actions as warranted, based upon inventory levels and demand velocity which determine critical stock position review points.

Engineering and Production Branch—The Engineering and Production Branch, AAC-440, is the part of the depot operation that provides repair, rehabilitation and modification services on equipment that are beyond the repair and overhaul capability of the field organizations. These include:

- Provide engineering services and drawings for major overhaul and modification work.
- Provide overhaul work on units that fail or have periodic depot overhaul schedules. These may include antenna drive units, special motors, servo units, radio frequency sub-assembly units, etc.
- Perform complex or difficult modifications, on equipment in Depot Stock, which are authorized by national orders.
- Provide engineering and technical documentation for overhaul and modification work to be done by in-house shops and/or contracte out.
- Provide complete rehabilitation for sys tems removed from service, returned to the depo and scheduled for installation at a new locatio as directed by the national program office.
- Design and provide special parts and elec tronic assemblies that may be required for ne installations.

This branch plays an important role in the im plementation of any new system such as MLS and supports its continued operation thereafter

Quality Control Branch—The Quality Con trol Branch, AAC-450, accomplishes the qualit control function for equipment and items pro duced or overhauled by the production branch It is also responsible for the quality assuranc of items that are contracted out by the Depot It must assure that such items pass a qualit check before being returned to the Depots inver tory or shipped directly to field facilities. Th actual factory inspection work may be done b ALG-420 or other government quality assuranc groups. However, the acceptance of the end iter back into the FAA inventory remains the respor sibility of the Quality Control Branch.

Cataloging Branch—The Cataloging Branch AAC-490, of the FAA Depot is responsible fo the appropriate cataloging of all systems, assem blies, parts, and materials which are introduce into the FAA inventory system. The catalogin procedure, once done manually and documente in catalogs, is now automated and all items ar recorded on microfiche for easy reference an use. The cataloging process involves cros referencing items with all other U.S. Goverr ment inventories, as there is only one Nationa Stock Number (NSN) for any given item in th overall U.S. inventory system. Because MLS a new system, all of its assemblies and parts wi be recorded and cataloged in the inventory sy tem. This must be done timely and in conce with program implementation planning so tha parts identification and provisioning will full support MLS installation and operation.

NAS Depot Support—The Depot provides a ogistics and supply support function for all NAS rojects. The Depot inventory and delivery sys-ems are vital to the installation maintenance and peration of the NAS systems. It is particularly ttuned to the requirements involved with instal-ation and operation of any new system such as ILS. Coordination between the MLS Program Office, the Depot, and the AAC Associate MLS Program Manager should provide for a smooth upport transition throughout the MLS imple-nentation period.

Aeronautical Center Procurement Division

The Procurement Division, AAC-70, supports MLS implementation through procurement action and contracting support to the Aeronautical Center. In the case of the MLS Program, this would include any spare/repair parts procurement and/or repair services required by the Depot. The division is a self-sufficient procurement division which consists of three branches: Procurement and Systems, Contracting, and Contract Management.

FAA REGIONS

The FAA Regions are organizations headed by a Regional Director who reports directly to he FAA Administrator. Each region is functionally responsible for the execution of FAA operations in the field within a specifically defined geographic area of the U.S. There are nine FAA regions.

- Alaskan, AAL
- Central, ACE
- Eastern, AEA
- Great Lakes, AGL
- New England, ANE
- Northwest Mountain, ANM
- Southern, ASO
- Southwest, ASW
- Western Pacific, AWP

A map showing the regional boundaries is provided in Figure 5-5.

Functions and Responsibilities

The regions are independent organizational entities that provide the full range of FAA aviation services in their designated area. The major functional support impact of the regions regarding the MLS Program is in the Airway Facilities, Flight Standards and Air Traffic areas. Of course, administrative support services such as budget, logistics and personnel are included to a lesser degree. Their role on the regional level is much the same as that described for like organizations at the National level.

FAA Regional Complex in Support of MLS

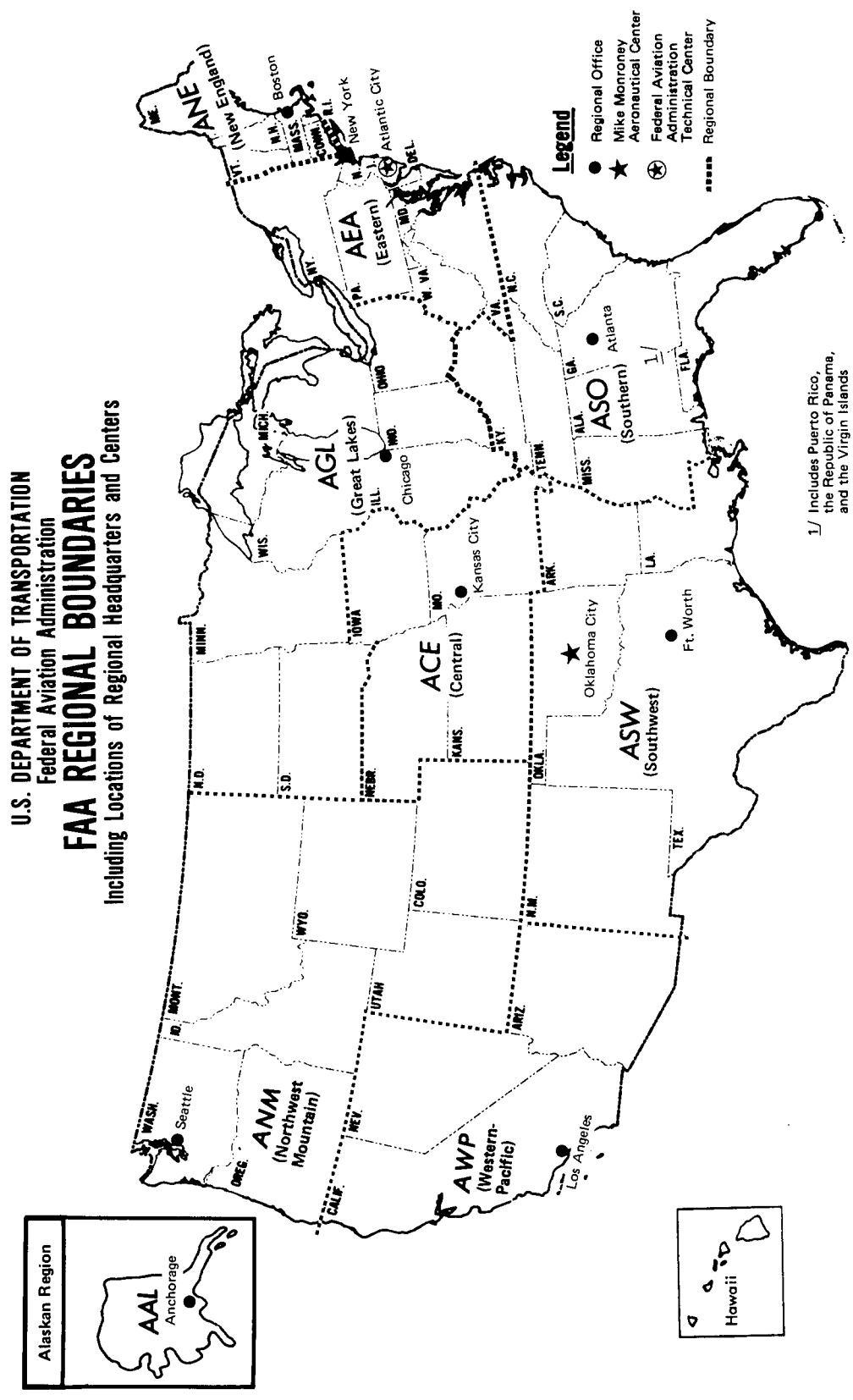
There are three primary areas in which the regions are involved in the MLS implementation process. The regions role in the MLS Program includes planning, facility establishment, commissioning, and facility operations; site specific ATC and TERPS procedures; and maintenance and support services.

Regional Airway Facilities Divisions

The Airway Facilities Divisions (400 Divisions) of the regions are the primary organizations tasked with the planning, establishment, commissioning and operation of the MLS ground systems. This in effect is a large part of the FAA MLS implementation task. A major activity of the division involves monitoring the work of the contractor, providing required inputs such as MLS site drawings, operational requirements, and reviewing contractor reports and work accomplishments.

As a means of monitoring and controlling site engineering work, the MLS Technical Officer in APM-410 has established a working group consisting of representatives from the concerned staff offices in the FAA regions and headquarters.

Review of project data checklist and site engineering report. The goal of the working group


U.S. DEPARTMENT OF TRANSPORTATION
Federal Aviation Administration
FAA REGIONAL BOUNDARIES
Including Locations of Regional Headquarters and Centers
Legend
Regional Office
Mike Monroney Aeronautical Center
Federal Aviation Administration Technical Center
Regional Boundary
ANE (New England)
Boston
New York
Atlantic City
AEA (Eastern)
AGL (Great Lakes)
Chicago
ACE (Central)
Kansas City
ASO (Southern)
Atlanta
ASW (Southwest)
Oklahoma City
Ft. Worth
ANM (Northwest Mountain)
Seattle
AWP (Western-Pacific)
Los Angeles
1/ Includes Puerto Rico, the Republic of Panama, and the Virgin Islands
Alaskan Region
AAL
Anchorage
Hawaii

as to review in-depth the contractor proposed te data package and the contractor's site eneering report (CSER) format to ensure that e approach meets the contract requirements, id provides appropriate feedback to the conactor. These actions will ensure that the site igineering process achieves the contract objecves and will establish a suitable pattern for site igineering work at all future sites.

Time-phased action plan. A time-phased acon plan was developed which identifies all sitelated actions that must be accomplished in the mmissioning of an MLS facility and normales the timing of these actions in relation to the ite of commissioning. The events in the plan ve been programmed on a computer and interpendencies between events determined. If ere is a slippage in any event, the impact on l other events can be quickly determined. It is iticipated that the action plan will be used by e regions as a checklist for the work at each e. Computerizing the data will permit all conrned offices to track progress toward comissioning.

The Airway Facilities Divisions are involved the MLS establishment process. They receive &E funds on each installation project to perrm all regional on site engineering work, esblishment support, and engineering and techcal support through commissioning. Once the LS facility is commissioned, they are responle for its maintenance and operations.

egional Flight Standards Divisions

The Flight Standards Divisions (200 Divisions) the regions are responsible for accomplishing e flight safety activities of the regions. Some the specific tasks that are directly associated th the MLS Program are:

- Ensure that site specific TERPS produres are available and published prior to anned commissioning of MLS ground systems their region.
- Monitor and evaluate avionics and aircraft d aircrew utilization of MLS.
- In coordination with AVN, determine the itial and recurring MLS Flight Inspection requirements within their region.
- Primary organization within the region to work with APR-100 and the regional budget staff for the selection of candidate MLS sites to be included in the annual budget call for estimates.
- Supervise demonstrations and tests in the region which involve the operational capabilities of MLS.

The Flight Standards Divisions also have the responsibility for ensuring that their personnel, both in operations and flight inspection are trained and fully familiar with the use and operation of MLS systems and standards.

Regional Air Traffic Divisions

The Air Traffic Divisions (500 Divisions) of the regions are responsible for the safe and efficient operation of aircraft within their assigned airspace. With MLS implementation now at hand they will need to develop ATC procedures and train operational personnel in the use of MLS. Their specific tasks in the near future will include:

- Develop MLS ATC procedures for each site prior to its commissioning.
- Coordinate with the National AAT organization for advice and guidance on procedures development.
- Determine training requirements for ATC Controllers in the utilization of MLS approaches and departures.
- Review staffing requirements.

Regional MLS Associate Program Managers

Each region has an MLS Associate Program Manager (PM). The Associate PM is named by the Regional Director and is the focal point in the region for the overall awareness of the MLS Program. The Associate PM maintains close contact and communications with the MLS Program Office and stays abreast of national MLS planning and status. The Associate PM in the region functions much in the same way that the Program Manager does nationally. The Associate PM is the key individual to ensure that

regional matrix management works effectively for the regional MLS program implementation. The Associate PM is the person to contact on all matters pertaining to MLS Program activities within a given region.

Regional MLS Implementation Program

The regions are expected to play an important role throughout the life of the MLS Program. Beginning in FY-86, the F&E call for estimates will require regions to submit locations for networks which support the area hubs described in the implementation strategy. In essence, the regions will use the Transition Plan, Order 7031.2B, and the MLS Implementation Plan to identify candidate sites. The regional recommendations will be reviewed in the same manner as other projects submitted in response to the call for estimates. The final approved listings will then be furnished to the regions, and to the contractor at least one year prior to scheduled equipment delivery. Each site location listed will include the required date, category of service and type of equipment to be used. Specifically, the regions will accomplish the tasks outlined below in support of MLS:

- Determine the specific runway(s) or heliport(s) on which a qualifying MLS candidate should be located in a given program year.
- Establish appropriate priority of network airports for MLS candidate sites that will best serve the users and at the same time support FAA's national implementation plan for MLS.
- In moving forward with their MLS implementation planning, the regions shall carefully examine all sites where a requirement for MLS exists. They should recommend that MLS be provided at locations where the desired level of service is presently not provided or planned (stand alone locations). The regions are in the best position to identify these types of sites. Strong justification shall exist for this consideration to ensure that it meets one or more of the following:

1. Supports a user operating into the airport that is MLS equipped.
2. Provides significant cost/benefit advantages.
3. Serves United States International MLS interest.
4. Increases airport capacity.
5. Provides early needed precision approach system capability for identifiable operational reasons: e.g., ILS was not technically feasible, MLS approach procedures solve a noise abatement problem, etc.

- Provide required information on any proposed "stand alone location" to the Program Management Division, APR-100, and the Program Office, APM-4A. Information regarding such sites should be provided to the national level at the earliest possible time.
- Consider how preferred MLS runways serve to increase airport capacity at each hub and network airport, fulfull an aeronautical need, and/or increase safety.
- Consider how the prioritizing of MLS sites within a given network tends to maximize the utilization and promotion of MLS to the largest segment of the aviation community within a given network.
- Consider the MLS planning and implementation impact at all locations whether installed as nonfederal facilities or by using Airport Improvement Project (AIP) funding.
- Maintain close coordination with FAA airport offices and outside elements on AIP and nonfederal implementation planning so as to maximize MLS utilization, users' support and promotional strategies in interfacing such facilities with planned FAA networking concepts.
- Plan for Automated Weather Observation Service at sites which have no FAA National Weather Service reporting capability.
- Maintain close coordination with the MLS Program Office and AVS.
- The regions have the responsibility for the acquisition of land for MLS and the supporting lighting systems, if required. These actions must be initiated far enough in advance so as not to delay equipment installation. In addition, they have the responsibility for plant and electronic engineering, electronic installation and flight inspection. Regional support funds will be provided for these regional work requirements.

Regional MLS Implementation Plans

Each of the regions are in the process of completing, or have completed, an MLS Implementation Plan for their individual regions. These plans are consistent with the national system implementation plan. Each region may be a little different in the approach to its planning but the overall objectives and goals are the same. Also, the level of activity in the regions will differ depending on the scheduled availability of hardware at a particular point in time.

Initial Regional Implementation

The Phase I activity will soon be underway and the first 15 sites are known. These sites comprise three networks which will be installed in Alaska, Denver and Boston areas. The regions involved will start their planning around these hub and network systems. As the program progresses, more and more regions will come into active MLS Program involvement.

There are different considerations in each region regarding MLS implementation planning. For example the Great Lakes network planning consists of a regional backbone system supplemented by FAA and nonfederal cluster networks in the state of Michigan. These combined networks compliment the already active State and Canadian programs and provide a unique opportunity to utilize all available resources to enhance MLS Program implementation.

Regional MLS Operations

The regions are now and will continue to be involved in a variety of MLS operational programs. In the early years of MLS development the operational programs were geared toward gaining operational experience whereas at present they are directed toward user acceptance, analysis and data collection. From this point on they will be directed more towards operational aspects to improve operational capability and enhance system performance.

MLS Demonstration Projects

The MLS Operational Demonstration Projects conducted in the Eastern Region are an example of what is going on in the field. An MLS was installed at the Wall Street Heliport in December 1984, and was moved to Battery Park in early 1985. That same system has been installed in Richmond, Virginia, and was commissioned in July 1985. While there are also commissioned systems in Alaska, Michigan, and Texas, the Richmond system is expected to attract more users largely because the FAA will provide 20 to 30 receivers to regular IFR users at Richmond. The demonstration will include as many different types of aircraft as possible. As a result of this program, the FAA will obtain supplemental type certificates for each of the participating aircraft. This will make subsequent MLS installations in those types of aircraft much easier.

MLS Facility Analysis Program

The Air Traffic Service has completed a facility analysis at two locations: Burbank, California, and the New York Terminal Area. The analysis in the New York area was to have considered Newark, JFK, La Guardia, and the Wall Street Heliport. However, as impacts on airspace were evaluated, it was found that the study had to be expanded to consider Teterboro, Westchester and Islip Airports and the West 30th Street, 60th Street, and 34th Street Heliports.

MLS STEP Program

Early in the MLS Program a number of sites were installed in the Eastern Region under the STEP program. The equipment used were prototypes built for FAA by Bendix, Hazeltine and Texas Instrument. They were for VFR tests only and were not commissioned. They are not compatible with the systems now being procured. For these reasons, STEP system replacement has a high priority.

MLS User Program

A user program is being planned by the Eastern and New England Regions to become operational in 1986. The sites under consideration are Boston, La Guardia and Newark. Eastern Airlines and Peoples Express are possible participants. The MLS ground equipment would be obtained by receiving early deliveries from the FAA production contract. A main objective of this program is to obtain early experience in an extremely active operational environment.

Eastern Region's MLS Activities

The Eastern Region has had a significant involvement in MLS during the early years of the program. Eastern Region's MLS Implementation Plan contains some 60 sites to be established over the next five years. The Eastern Region's involvement and participation in the program is typical of the activities to be expected in the other regions.

MLS Video Tape

The FAA has produced a video tape on MLS and has provided it to all regions. This video tape is intended to identify the operational capabilities of MLS to aviation related audiences. The tape is available and can be released by the regions to non-FAA groups. It provides a good look at MLS capabilities in normal approaches when applied to specific problem sites and congested terminal areas.

MLS PROGRAM IMPLEMENTATION AND OPERATION SUMMARY

This examination of the many FAA organizations supporting the MLS Program reveals the Program's scope and complexity. Each organization has been identified and its MLS support role highlighted. Each organization is a part of the MLS matrix management team, the approach used by FAA for the implementation of this program. For the purpose of simplicity, each organization's activities as related to the MLS Program will be summarized.

ADL

The Development and Logistics (ADL) organization has the lead role in the development, acquisition, installation, maintenance and operation of the MLS ground system hardware. Most of the development work is now complete and the equipment acquisition and implementation stage is well underway.

APM

The Program Engineering and Maintenance Service (APM) is the organization within ADL that is responsible for the acquisition and implementation of the MLS ground systems. The MLS Program Office is a part of this organization and it provides the necessary guidance and direction on the overall MLS Program. Also, the Program Office has the responsibility to fulfill the agency's MLS mission by managing the program through matrix management concepts and techniques. The APM Service also has the responsibility for the planning and provision of maintenance programs to support MLS, in particular the '80s Maintenance Program.

AES and ACT

Two other organizations within the ADL complex support MLS: Systems Engineering Service (AES) and the Technical Center (ACT). The Systems Engineering Service provides engineering and technical support to the MLS Program and is the office charged with contract and management responsibilities for the SEI Contract. Martin Marietta is the SEI Contractor and is responsible for the NAS Plan implementation. The Technical Center has test and evaluation responsibilities in direct support of MLS implementation. The center also has the responsibility for the development, maintenance and control of the MLS math model which is used to evaluate MLS performance at a specific location prior to installation.

AVS

The Aviation Standards (AVS) organization has the lead role in MLS implementation in all areas of operational requirements. It has the responsibility for the identification of proposed MLS candidate sites and works with the regions in finalizing these lists on an annual basis through the budgetary process. They also are responsible for the development of policy and procedures which pertain to the operational environment in the development and utilization of MLS.

\FO

The Office of Flight Operations (AFO), which s a part of the AVS complex, plays a major role n the development of MLS policy and proce- lures. A significant task at the outset of the MLS 'rogram is in the development of the TERPS nd Flight Inspection procedures. AFO is also esponsible for the airborne avionics equipment evelopment and operation. In addition, they ave management and oversight responsibilities or the conduct of any required MLS demonstra- ion projects, such as the, "Richmond MLS)emonstration Project". In general, this office rovides the management function for FAA on ILS implementation matters in the operations rea.

\VN

The Aviation Standards National Field Office AVN) is located in Oklahoma City and serves s a field arm of AVS. They are actively involved ı the work programs associated with the devel- pment of FI/TERPS procedures. Their role in ıis area is defined by an MLS Program Direc- ve. The office has an operational role in pro- iding Flight Inspection services worldwide for AA. In the MLS area, they are responsible for lanning for and having aircraft, equipment and ·ews available to accomplish the commission- ıg and recurring Flight Inspection support for ILS facilities being installed in accordance with ıe MLS implementation plan.

\RO

The Rotorcraft Program Office (ARO) is re- ɔonsible for the Rotorcraft Master Plan, and s a part of that, the All-Weather Heliport De- elopment and Demonstration Program. The ILS Program will provide the necessary equip- ıent and procedures (both TERPS and ATC) ɔ support these programs. Special consideration ·garding MLS Flight Inspection and operation : heliports are coordinated as a part of the MLS nplementation process.

\WS

Other AVS offices also support MLS on a less equent basis, such as air-worthiness. Their sup- ɔrt activities are fully coordinated by AVS and ıe MLS Program Office.

AAT

The Air Traffic Organization (AAT) will have a major role in the operation and movement of aircraft in the terminal areas utilizing MLS once these systems are commissioned. At the present time, AAT is involved in an MLS ATC Procedures Development Program which consists of two projects: Procedures Analysis and Facility Analysis. The information gained from these projects will be used to establish policy and guidance for the provision of site specific ATC Procedures. The training of air traffic controllers in the use of MLS is in the planning stages and must be completed prior to MLS commissionings. With these things in mind, the Air Traffic System will be ready for terminal operations utilizing MLS within the near future.

ARP

The Airports Organization (ARP) can provide support and compliment the MLS program by providing MLS systems to airports with funding under the Airport Improvement Program. At present, APS 1 criteria makes it very difficult for an airport operator to qualify or justify the acquisition of MLS using AIP funds as it competes with the F&E MLS Program. There is also a problem with the FAA takeover policy of non-federal facilities. These two matters are currently under review within FAA. The establishment of MLS at airports should provide an increase in airport utilization and runway capacity.

API

The Policy and International Aviation Organization (API) provides support to the MLS Program through their role in formulating MLS policy and managing the APS 1 criteria and MLS qualification process. They also have the ASARC and environmental responsibilities for the FAA. The Office of International Aviation has the lead role to support the MLS Program internationally through its interface and participation with foreign countries and international bodies. They can also arrange for direct field liaison through worldwide FAA representatives and the Europe, Africa and Middle East Office and U.S. Embassies.

AAD

The Administrative Organization (AAD) provides a number of MLS support services. The Materiel and Acquisition Service plays a significant role in the MLS Program by providing contracting, materiel management and factory inspection services. The budget office is involved with the budgetary requirements of the MLS Program.

AHR

The Human Resource Management organization provides support services to the MLS program in all areas involving human resources. In particular, its Personnel and Technical Training Office provides for personnel management and training support services in direct support of MLS planning and implementation. The personnel of any organization is its greatest asset and within FAA and all of its programs the well being and effective utilization of its people is given the very highest priority.

APA

The Public Affairs Office (APA) has the responsibility to keep the public and employees of FAA informed on significant events and matters of interest. They support the MLS Program by developing public news releases and by working with the MLS Program Office to produce video tapes, pictures, graphic materials and to assist in the preparation of articles for magazines and professional journals. They also publish two documents to keep employees informed on MLS events and happenings. These are the FAA "Intercomm" and the FAA *World*.

ASF

For the Office of Aviation Safety, MLS is an additional system that has a number of inherent characteristics that enhance safety. These safety features are related to siting flexibility, wide-angle coverage, signal quality and other new functions.

AAC

The Aeronautical Center (AAC) is located in Oklahoma City and provides two major elements of support to the MLS Program: the Depot and Academy. The FAA Depot is the single point for overall spare parts and warehousing support. The Depot also provides overhaul modification and repair services for electronic equipment and sub-assemblies. The FAA Academy is the technical training center for the FAA. It supports the MLS Program by providing technical training and seminars for FAA Engineers, Technicians, Air Traffic Controllers, Flight Standards Specialists and Managers.

Regions

The FAA regions provide a full range of FAA aviation services in their geographic areas. They are deeply involved in the MLS implementation process. Each Regional Director has appointed a Regional MLS Associate Program Manager to monitor and coordinate all MLS matters nationally and within the region. The elements of the regions that have significant MLS involvement are: Airway Facility, Flight Standards, and Air Traffic Divisions. These organizations have similar roles in the MLS Program to those in like organizations at the national level. The Airway Facility Divisions are involved with the MLS ground station engineering, installation and commissioning. The Flight Standards Divisions are involved with procedures, flight inspection and operational matters. The Air Traffic Divisions are involved in ATC procedures development, training and operations. The regions play an important part in the MLS implementation planning and establishment and have a continuing responsibility in its operation and maintenance once a facility is commissioned.

The knowledge of what these various organizations do in support of MLS provides a better understanding of how the MLS implementation process is tied together by the MLS Program Office. Schedules are maintained to ensure the completion of predetermined tasks to meet the specific requirements of the master schedule of the MLS Implementation Plan. This process, and the support of the offices involved, will guide MLS implementation through to a successful conclusion.

Appendices

APPENDIX A

GLOSSARY OF ABBREVIATIONS

AAC	— Mike Monroney Aeronautical Center
AAD	— Associate Administrator for Administration
AAL	— Alaskan Region
AAS	— Office of Airport Standards
AAT	— Associate Administrator for Air Traffic
ABU	— Office of Budget
ACE	— Central Region
ACT	— FAA Technical Center
ADL	— Associate Administrator for Development and Logistics
AEA	— Eastern Region
AEE	— Office of Environment and Energy
AES	— Systems Engineering Service
AEU	— Europe, Africa, and Middle East Office
AFIS	— Automated Flight Inspection System
AFO	— Office of Flight Operation
AGL	— Great Lakes Region
AHR	— Office of Human Resource Management
AIA	— Office of International Aviation
AIAs	— Annual Instrument Approaches
AID	— Agency for International Development
AIM	— Airman's Information Manual
AIP	— Airport Improvement Program
ALG	— Acquisition and Materiel Service
ALPA	— Air Line Pilots Association
ANE	— New England Region
ANM	— Northwest Mountain Region
ANSI	— American National Standards Index
AOA	— Office of the Administrator
AOPA	— Aircraft Owners and Pilots Association
APA	— Office of Public Affairs
API	— Associate Administrator for Policy and International Aviation
APM	— Program Engineering and Maintenance Service
APO	— Office of Aviation Policy and Plans
APP	— Office of Airport Planning and Programming
APS 1	— Airway Planning Standard #1
APT	— Office of Personnel and Training
ARD	— Approach Reference Datum
ARINC	— Aeronautical Radio, Incorporated
ARO	— Rotorcraft Program Office
ARP	— Associate Administrator for Airports
ASARC	— Aviation Systems Acquisition Review Committee
ASF	— Office of Aviation Safety
ASO	— Southern Region
ASR	— Airport Surveillance Radar
ASW	— Southwest Region
ATA	— Air Transport Association
ATC	— Air Traffic Control
ATCT	— Air Traffic Control Tower
ATO	— Air Traffic Operations Service
AUX	— Auxiliary
AVN	— Aviation Standards National Field Office
AVS	— Associate Administrator for Aviation Standards
AWOP	— ICAO All-Weather Operations Panel
AWOS	— Automated Weather Observation System
AWP	— Western Pacific Region
AWS	— Office of Airworthiness
AZ	— Azimuth
BAZ	— Back Azimuth
CAAGs	— Civil Aviation Assistance Groups

CAT — Category
CBI — Computer Based Instruction
CFI — Contractor Furnished Installation
CONUS — Continental United States
COTR — Contracting Officer's Technical Representative
CRT — Cathode Ray Tube
CSER — Contractor's Site Engineering Report
CTOL — Conventional Takeoff and Landing
D.C. — District of Columbia
DCA — Washington National Airport
DH — Decision Height
DME — Distance Measuring Equipment
DME/P — Precision Distance Measuring Equipment
DMSA — Designated Major System Acquisition
DOD — Department of Defense
DOS — Department of State
DOT — Department of Transportation
E&R — Exchange and Repair
EFIS — Electronic Flight Instrumentation System
EL — Elevation
FA — Final Approach
FAA — Federal Aviation Administration
F&E — Facilities and Equipment
FAR — Federal Air Regulations
FBMLS — Fixed Base Microwave Landing System
FCC — Flight Control Computer
FI — Flight Inspection
FIFO — Flight Inspection Field Office
FMC — Flight Management Computer
FO — Functional Organization
FPM — Federal Procurement Manual
FRP — Federal Radio Navigation Plan
FY — Fiscal Year
GA — General Aviation
GAMA — General Aviation Manufacturing Association
GCA — Ground Controlled Approach
GP — Glide Path
GPI — Glide Path Interception Point
GPS — Global Positioning System
GS — Glide Slope
IA — Initial Approach
ICAO — International Civil Aviation Organization
ICLS — Instrument Carrier Landing System
ICS — Integrated Communications System
IDCA — International Development Cooperation Agency
IFB — Invitation For Bids
IFO — International Field Office
IFR — Instrument Flight Rules
ILS — Instrument Landing System
JCS — Joint Chiefs of Staff
KDM — Key Decision Memorandum
LOC — Localizer
MAC — Military Airlift Command
MAP — Missed Approach Point
MATCALS — Marine Air Traffic Control and Landing System
MDA — Minimum Descent Altitude
MIL STD — Military Standard
MIT — Massachusetts Institute of Technology
MLS — Microwave Landing System
MM — Middle Marker
MMC — Maintenance Monitor Console
MMR — Multi-mode Receiver
MOA — Memorandum of Agreement
MOPS — Minimum Operational Performance Standards
MPS — Maintenance Processor Subsystem
MRAALS — Marine Remote Area Approach and Landing System
MTBO — Mean Time Between Outages
MTFB — Mean Time Between Failure
NAS — National Airspace System
NASP — National Airspace System Plan
NASA — National Aeronautics and Space Administration
NATO — North Atlantic Treaty Organization

NBAA — National Business Aircraft Association
NM — Nautical Mile
NMLS — National Microwave Landing System
NPPD — NAS Plan Program Director
NSN — National Stock Number
OAG — Official Airline Guide
OM — Outer Marker
OMB — Office of Management and Budget
OSD — Office of the Secretary of Defense
OST — Office of the Secretary of Transportation
PAR — Precision Approach Radar
PD — Program Directive
PDR — Preliminary Design Review
PM — Program Manager
PMIS — Program Management Information System
PR — Procurement Request
QA — Quality Assurance
QOT&E — Qualification Operational Test and Evaluation
RAA — Regional Airline Association
RCVR — Receiver
R&D — Research and Development
R&R — Repair and Return
RFP — Request For Proposals
RMMS — Remote Maintenance Monitoring System
RTCA — Radio Technical Commission of America
RMS — Remote Maintenance Subsystem
RMSC — Remote Monitoring Subsystem Concentrator
RNAV — Area Navigation
RTCA — Radio Technical Commission for Aeronautics
RTT — Radio Telemetering Theodolite
RVR — Runway Visual Range
SAM — System Acquisition Management
SARPs — Standards and Recommended Practices
SC — Special Committee
SEI — System Engineering and Integration
SEIC — System Engineering and Integration Contractor
SIP — System Implementation Plan
STC — Supplemental Type Certificate
STEP — Service Test and Evaluation Program
STOL — Short Takeoff and Landing
TACAN — Tactical Air Navigation
TCH — Threshold Crossing Height
TERPS — Terminal Instrument Procedures
TOR — Technical Officer's Representative
TRSB — Time Reference Scanning Beam
TSC — Transportation System Center
TSO — Technical Standard Order
UK — United Kingdom (Great Britain)
U.S. — United States
USA — United States Army
USAF — United States Air Force
USMC — United States Marine Corps
USN — United States Navy
VFR — Visual Flight Rules
VHF — Very High Frequency
VOR — Very High Frequency Omni-directional Range
V/STOL — Vertical/Short Takeoff and Landing
VTOL — Vertical Takeoff and Landing
WOP — Weather Operations Panel

APPENDIX B
PROGRAM MANAGER'S CHARTER

1.0 *Purpose*

This charter defines the Program Manager's (PM) functions/responsibilities, authority, accountability, program schedules, financial resources, and expected results. Also defined are the relationships between the Microwave Landing System PM and the supporting Federal Aviation Administration (FAA) organizations.

2.0 *References*

a. DOT 4200.14B, Major Systems Acquisition Review and Approval, January 6, 1983.

b. FAA 1810.1C, Major Systems Acquisition, August 12, 1982.

c. Microwave Landing System Key Decision Memorandum, April 1983.

3.0 *Functions and Responsibilities*

The functions and responsibilities of the MLS PM are to manage all FAA activities necessary to implement the MLS successfully. In this regard the PM, using the matrix management process, is responsible for the design, development, test, evaluation, production, installation, and integration of the MLS into the National Airspace System (NAS).

The MLS Program description, major functions and duties, the mechanism for acquiring support commitments from other FAA organizations, budget/financial management, and Program Office operations are outlined within this section.

3.1 *Program Description*

The Microwave Landing System (MLS) is an air derived system in which ground based equipments transmit position information signals to a receiver in the landing aircraft. The position information is provided at angle coordinates and a range coordinate. The angle information is derived by measuring the time difference between the successive passages of highly directive, narrow, fan-shaped beams which inherently provide an accurate means for the time measurements. The range information is provided by the distance measuring equipment (DME) technique. This technique has been adapted for MLS to provide an accuracy of 100 feet or better in the final approach sector.

The MLS signal format is time-multiplexed; i.e., it provides information in sequence on a single carrier frequency for all the angle functions (azimuth, elevation, flare, and back azimuth). The format includes a timeslot of 360 degrees azimuth guidance as well as provisions for additional growth functions. The angle guidance channel plan provides 200 C-band channels spaced 300 kHz apart, between 5031 and 5091 MHz. The ranging channel plan also provides for 200 channels.

For the angle functions (i.e., azimuth and elevation), narrow fan-shaped beams are generated by the ground equipment and scanned electronically to fill the coverage volume. In azimuth, the beam scans horizontally and has a vertical pattern that is shaped to limit illumination of the airport surface.

Precision azimuth guidance is furnished to a distance of not less than 20 nautical miles from touchdown and up to ± 60 degrees from the runway centerline extended. In elevation the antennas are designed to minimize unwanted radiation that is directed toward the airport to minimize unwanted radiation that is directed toward the airport surface and, thereby, provide accurate guidance to very low angles. Vertical position data is provided up to 20 degrees above the horizontal.

A ground-to-air data communications capability is provided throughout the angle guidance coverage volume by stationary sector coverage beams that are also designed to have sharp lower-side cutoff. This communications capability is used to transmit the parameters of each angle function that are required by the aircraft receiver and for displays used by the pilot, and to relay information (auxillary data) needed for all-weather operations.

The airborne equipment receives the ground generated sector and scanning beam signals associated with each angle function and, in sequence, determines the identity of the angle function and then detects the scanning beam angle information. It subjects the received signals to acquisition criteria before they are accepted and continues validation following acceptance to provide reliable interference-free angle information.

The benefits of MLS derive from the following main system characteristics:

- Availability of 200 channels
- Continuous angle and range indication
- Improved signal quality
- Reduced sensitivity to siting and the environment
- Large guidance coverage sectors
- Digital system design and use of advanced technology

3.2 *Major Functions and Duties*

The major functions and duties of the MLS PM are as follows:

a. Provides direction, solicits, identifies, coordinates, and integrates the efforts of all participating organizations, within and outside the FAA, so as to ensure timely and effective accomplishment of mission.

b. Initiates, directs, and coordinates the preparation of required program documentation plans, and reports in accordance with the provisions of Departmental and agency orders.

c Reviews, directs and makes recommendations concerning procurement request (PR) packages and specifications required for the development, production, and implementation of the MLS.

d. Provides the leadership and direction necessary for arriving at an agency decison to determine installation priorities and site location schedules.

e. Insures that determinations of decommissionings and consolidations are made consistent with existing policy, criteria and are supportive of national planning so as to best accommodate users requirements.

f. Develops the concepts and directs agency activities necessary to neutralize unwarrante and unjustified adverse attacks on the progam by users, outside organizations or special interest groups.

g. Develops in consultation with appropriate performing organizations and maintains all MLS budgetary requests, reports, reprogramming, and other aspects of the MLS budgetary items.

h. Assures the adequacy of financial resources to participating organizations supporting the MLS Program.

i. Implements and maintains a program control and tracking system to support the management process and provides for timely status on program accomplishments.

j. Assures the application of agency configuration management procedures to the MLS Program.

k. Coordinates MLS Program activities with those of other related agency programs in the NAS Plan.

l. Recommends to the Administrator, after consultation with performing organizations and appropriate executive level coordination through ASARC, any indicated revisions to requirements and resources necessary to accomplish the mission.

m. Serves as a liaison with other Government agencies and groups from the aviation user community.

n. Serves as spokesman for the MLS Program and disseminates MLS Program information in accordance with FAA and DOT regulations.

o. Serves as focal point for interdepartmental, Congressional, and public coordination of the MLS Program.

p. Reports program status to ASARC quarterly or as required.

.3 *Supporting Organizations*

The PM will accomplish the majority of his functions by the use of matrix management techniques using established functional organizations. Such an approach will enable the PM to integrate the efforts of a broad range of supporting organizations. These organizations include FAA headquarters, FAA centers, and may involve other Government agencies.

The PM will negotiate official agreements, when required, with each support organization. These agreements, known as program directives (PD), will spell out the tasks to be performed, products to be delivered, time schedules, and resource requirements. Signed PD's will commit the functional organization to satisfactory completion of agreed upon tasks within the allotted time frame. The "PD" concept will facilitate effective tracking of supporting organizations' activities and, in so doing, offer greater potential to the PM to minimize adverse schedule impacts.

The PM retains responsibility for satisfactory performance of such task agreements including the responsibility to initiate termination of tasks and establishing alternate sources for their accomplishment. The PM is responsible for overall management of program directives, periodic review of program directive accomplishments, tracking of program resources consumed, and for final review and approval of all tasks and products.

.4 *Budget and Financial Management*

The PM is responsible for coordinating all aspects of FAA's programming and budgeting

system as they pertain to the program, working within FAA's established budgetary system. He coordinates through the appropriate Associate Administrator to ensure integration with other agency priorities. The Administrator's approval is required for changes in planned application of budgetary resources and for any budget action which will result in exceeding the limits set for such approval in the Program Master Plan. He uses necessary budgetary information to monitor financial performance, recommends reprogramming in the current year, and new programming recommendations for succeeding years. Collaborates with the Office of Accounting and functional organizations in the validation of outstanding obligations and the application of capitalization criteria.

3.5 *Program Office Operations*

The PM is repsonsible for establishing and maintaining an MLS Program Office. This office will be staffed at a level commensurate with current requirements. The PM will develop and document the responsibilities of each element within the MLS Program Office. The Program Office will implement and maintain a tracking information system capable of providing timely status reports on program progress using ADL approved methods.

It is recognized that as the program develops, staffing needs may vary and changes may be required in the MLS Program Office. This charter authorizes the PM, in coordination with the Service Director, to make necessary changes within the constraints of existing FAA personnel ceiling and regulations.

4.0 *Authority*

The PM's responsibilities, as outlined in this document, obligate him to perform program tasks that involve many of the functional line organizations, both in the FAA headquarters and field offices. The PM's authority must be commensurate with this responsibility.

Subject to the responsibilities and limitations described herein, the PM is delegated the authority to act for the Administrator, Associate Administrator, or Service Director to develop and implement successfully an MLS which fully satisfies the requirements outlined in the MLS Master Plan. Other organizational elements of the FAA shall look to the PM as the focal point responsible for determining how the efforts of all organizations combine to meet the requirements of the program. The PM is responsible for and will insure coordination of all related MLS program activities in conjunction with such organizations.

The PM is further delegated the authority to establish plans, to define all activities necessary for program accomplishment, to establish priorities, to set schedule and funding objectives, to negotiate program directives (contracts) with line ogranizations, to manage, review and approve all program products including planned procurements and contracts, and to exercise the program, engineering, budget and fiscal controls necessary to accomplish the MLS Program. The PM will also establish systems for the provision of management information commonly applicable to and required by all FAA supporting organizations to assure the availability of data and other information needed to fulfill his responsibilities.

The PM will exercise his authority at the direction of the Administrator within the confines of the program as approved by the Administrator and within the constraints of applicable regulations and this Program Manager's Charter. The Key Decision Points identified in FAA Order 1810.1C, Systems Acquisition Management, and as may later be revised,

are specifically defined as being beyond the PM's authority and subject to the authority of the ASARC and the Administrator.

5.0 *Accountability*

In fulfilling his responsibilities for the direction of the MLS Program, the PM, as directed in 1810.1C for Designated Major Systems Acquisitions, is personally accountable to the Administrator for successful management and accomplishment of the program. Accountability to the Administrator may be in the form of personal reporting or via program reviews; ASARC meetings and by other appropriate formal and informal means.

For the purposes of general supervision, integration and planning in connection with the MLS or other agency programs, the PM will initially coordinate his activities through the APM Service Director and the Associate Administrator for Engineering and Development. The APM Service Director provides first-level performance appraisal, policy guidance, and technical advice to the PM, and the PM consults with the Service Director before bringing matters before the Associate Administrator or Administrator. The PM's ability to cope and plan for uncertainties affecting program success which are beyond his control is a major and valid means by which his performance is measured and evaluated.

The PM is given extensive authority and responsibility by this Charter. Accountability for management and performance will be evaluated by the Administrator in terms of exercise of authority, fulfillment of responsibilities, and management decision making. An objective measure of performance will be the Program Manager's success or failure in meeting cost, schedule, and performance milestones and eventually, the success or failure in delivering to the users a system that meets their needs, on time and within costs.

APPENDIX C
MLS PROGRAM DIRECTIVE (SAMPLE)

APM-4A/AVN-1-84-001
PROGRAM DIRECTIVE AGREEMENT

PROGRAM DIRECTIVE AGREEMENT
Between
MICROWAVE LANDING SYSTEM PROGRAM OFFICE, APM-4A
and
AVIATION STANDARDS/NATIONAL FIELD OFFICE
AVN-1

SUBJECT: SUPPORT OF THE FAA's MLS PROGRAM TO DEVELOP FLIGHT INSPECTION AND TERMINAL INSTRUMENT PROCEDURES CRITERIA

SUMMARY: This Program Directive (PD) identifies the requirements and provides for a method to fund the associated tasks and provide the support services for AVN to develop Flight Inspection and Terminal Instrument Procedures Criteria for Fiscal Year 84, 85 and 86 in support of the MLS Program. This directive identifies the specific tasks that are to be performed and the responsibility of AVN to see that such tasks are performed when appropriate funding is available to them. To ensure that this funding is available to AVN, the MLS Program Office (APM-4A) will arrange to have funding transferred from the MLS Program to AVN for FY-84 and 85 in the amounts identified for those years by this directive. For FY-86 AVN will include these costs for the tasks identified for that year in this PD in their FY-86 annual budget request. This PD is a negotiated agreement between the Program Manager and AVN. This agreement will be updated as required.

APPROVALS:

BY _____ DATE: APR 2 4 1984
Program Manager, Microwave Landing
Systems Program Office, APM-4A

By _____ Date APR 2 3 1984
Director, Aviation Standards
National Field Office, AVN-1

Revision No.	Date	Pages	APM/AVN Initials

PART I, MANAGEMENT DIRECTION: AVN will provide an appropriate level of support to the Microwave Landing System (MLS) Program to accomplish the work activities described herein within the constraint of the stated schedule. During the performance of these activities there will be periodic meetings between APM-4A and AVN-1 to ascertain progress toward meeting program objectives.

Primary technical support responsibility for the development of flight inspection and terminal instrument procedures, standards and criteria are the responsibility of AVN. The specific tasks to be performed and their associated costs and required resources are identified in Table 1 and 2 which are attached and made a part of this Program Directive. AVN's Critical Areas of tech nical support is related to administration, management and monitoring of task related contract and the development and provision of various documentation associated with tasks in Tables 1 and 2 and as further described in the following section:

A. *Flight Inspection Tasks (Table 1A)*

1. Provide necessary in-house and contract support to ensure completion of Items 2 through 9.

B. *Terminal Instrument Procedures Tasks (Table 1B)*

1. Provide necessary in-house and contract support to ensure completion of Items 1 through 21.

C. *Technical Support*

1. AVN MLS technical support responsibilities are in the following areas:

   a. Develop and provide FI/TERPS procedures in accordance with tasks in Table 1 in support of the MLS program.

   b. Prepare, coordinate and finalize publications, charts, directives and other documentation as identified in Table 1.

   c. Provide for the necessary aircraft and flight hour support necessary to obtain data and provide support of applicable tasks identified in Table 1.

   d. Provide or ensure that the necessary FAA support personnel are available to manag and accomplish work identified in Table 1.

   e. Arrange, manage and monitor contract activities necessary to accomplish applicable tasks identified in Table 1.

2. Technical Information Requirements of AVN

   a. Responsible for the review of all documentation generated by contractors or in-house FAA personnel in support of tasks in Table 1.

   b. Provide all technical documentation to AMP-4A for review once it is in final draft form and prior to the time it is placed into the formal coordination process for implementation.

   c. Provide guidance to and coordinate with the MLS Program Manager, AAT, APO, APT, AAC, ACT, and the Regions in regard to criteria, procedures, directives and other documentation covered by this Program Directive.

D. *Milestones/Deliverables*: Key milestones/deliverables and dates required from AVN in support of the MLS Program are shown in the following table. Items relate directly to tasks on Table 1.

Items	Milestones/Deliverables	Remarks	Date
A1	FI system calibration N-4	Completed	—
A2	RTT Procedures	Complete	9/30/84
A3	Develop FI Procedures	Complete	9/30/86
A4	FI training	Complete	9/30/85
A5	Directives FI Non-Fed and FAA MLS	Complete	9/30/85
A6	Directives FI reports	Complete	9/30/85
A7	Directive FI log	Complete	9/30/85
A8	Directives FI Non-Fed & Military	Complete	9/30/85
A9	Historical Data	Complete	9/30/85
B1	CTOL straight-in and azimuth offset Cat A & B aircraft	Complete	9/30/85
B2	CTOL straight-in transport Cat C aircraft	Complete	9/30/85
B3	MLS/RNAV for CTOL Cat A & B aircraft	Complete	9/30/86
B4	MLS/RNAV for CTOL transport Cat C aircraft	Complete	9/30/86
B5	MLS curved path for CTOL transport Cat C aircraft	Complete	9/30/85
B6	MLS Category III approach criteria for CTOL aircraft	Complete	9/30/86
B7	MLS STOL straight-in criteria up to 8 degrees	Complete	9/30/85
B8	MLS/RNAV approach criteria for STOL aircraft	Complete	9/30/86
B9	MLS curved approach for STOL aircraft	Complete	9/30/86
B10	MLS CAT III criteria for STOL aircraft	Complete	9/30/86
B11	Rotorcraft discrete airport straight-in and azimuth offset steep angle approach criteria for MLS split sites	Complete	9/30/84
B12	MLS helicopter approach criteria to a collocated MLS site on a heliport	Complete	9/30/85
B13	MLS helicopter full capability complex (curved) approach	Complete	9/30/85
B14	MLS helicopter CAT III straight-in steep angle approach criteria	Complete	9/30/86
B15	ICAO, OCP/MLS Working Group	Ongoing	
B16	IAPA — MLS mathematical models programmed into IAPA	Complete	9/30/85
B17	MLS approach plate charting requirements	Complete	9/30/84
B18	MLS Publications — AIM and ACS	Complete	9/30/85

Items	Milestones/Deliverables	Remarks	Date
B19	MLS Training Program for procedures specialist	Complete	9/30/85
B20	Joint FAA/USAF MLS Cat D & E straight-in offset, RNAV approach criteria	Complete	9/30/86
B21	MLS CTOL straight-in transport Cat C aircraft (Turboprop)	Complete	9/30/85
B22	Second MLS airborne data acquisition recording system for advance FI/TERPS data collection	Completed	
B23	Data conversion package	Completed	

E. *Management Coordination*: To assure coordination between the MLS Program Office and AVN, AVN personnel will perform the following activities:

1. Provide a monthly written status report on all items which have not been completed and discuss this report with APM-4A by telephone or in person.
2. Keep the MLS Program Manager informed on any items likely to cause schedule, cost, or functional impact to the MLS Program and provide quarterly written updates on the status of key AVN MLS Program responsibilities to coincide with DMSA quarterly program reviews.
3. Participate in all MLS meetings, and briefings related to AVN's areas of responsibility as indicated in this directive.

PART II, RESOURCES: AVN requires an appropriate level of resources to accomplish the work activities described in Part I. Provision of these resources will be furnished by the MLS Program Office and AVN as described herein:

A. *Resources Furnished by the Program Office*: The MLS Program Office will coordinate on funds and ensure that funds are made available from appropriate budget sources within the ADL complex to support this effort in FY 84 and 85 as identified in Tables 1 and 2 and in accordance with the following:

1. APM-4A will initiate action to provide the funds for FY-84 to AVN immediately upon consummation of this agreement.
2. APM-4A will coordinate and initiate action to provide FY-85 funds to AVN as soon as possible after Oct. 1, 1984.

B. *Resources Provided by the Functional Organization*

1. AVN will commit sufficient personnel and financial resources to accomplish the work activities described in Part I and further identified in Tables 1 and 2.
2. AVN will arrange and budget for those additional financial resources required to accomplish the work activities described in Part I and further identified in Tables 1 and 2 for FY-86. They will also commit sufficient personnel to support these tasks in FY-86.
3. AVN will coordinate with and arrange for the necessary support from other organizational elements of Aviation Standards to fully support the tasks identified in Part I of

this Program Directive. This includes obtaining personnel services from such organization and where applicable making sufficient funding available to them for their efforts in completing their portion of the tasks identified in Part I.

C. *Resource Tracking*: AVN will be responsible for tracking resources it consumes. Reports will be provided to the Program Office and indicate the following information: total allocation for fiscal year; amount expended/obligated in most recent reporting period; cumulative amount expended for fiscal year; expenditures anticipated for remainder of fiscal year; expected over/underrun. This information will be provided for the following categories of expenditures: overall expenditures of Program funds; contract, flight operation and travel expended and charged to the applicable appropriation.

AVN will report any financial problem situations, such as delays resulting in program cost growth, to the MLS Program Office as soon as they are recognized.

Program Funding Requirements for FY-84, 85, and 86 for: MLS Flight Inspection and Terminal Instrument Procedures (FI/TERPS) Criteria Development

Funding requirements required to provide timely solutions to the flight inspection and terminal instrument procedures criteria development program have been identified in Tables 1 and 2 and will be the responsibility of the FAA MLS Program Office. Allocation of funds by major project (task) will be geared to promote priority effort for operational implementation of flight inspection and terminal instrument procedures criteria to enhance the full spectrum of the MLS.

Table 1 — Flight Inspection and Terminal Instrument Criteria Development Funding Requirements ($000)

Major Projects (Tasks)	Flight Hours	Per Diem	Data Reduction	Contract Engineering Support
A) Flt. Inspection				
1. Calibration of MLS flight inspection system installed on BE-200 (N-4)	4.5K	.8K		
2. Radio Telemetering Theodolite (RTT) Procedures	4.5K	.8K		
3. Develop MLS Flight Insp. Procedures for CTOL, STOL, and Helicopters	486.8K	49K		100K
4. Flt. inspection training for MLS	In-house			

Major Projects (Tasks)	Flight Hours	Per Diem	Data Reduction	Contract Engineering Support
A) Flt. Inspection (con't)				
5. Directives — Flight Inspection of FAA and Non-Federal MLS's, FAA Order 8260.XX	In-house			
6. Directives — Flight Inspection Reports, FAA Order 8240.36A	In-house			
7. Directives — Flight Inspection Log, FAA Order 4040.9	In-house			
8. Directives — Flight Inspection of MLS — FAA, Non-Federal, and U.S. Military, FAA Order OA P 8200.1	In-house			
9. MLS Historical Data	In-house			
B) Terminal Instrument Procedures (TERPS)				
1. CTOL straight-in and azimuth offset CAT A & B aircraft	37.5K	8K	100K	
2. CTOL straight-in transport CAT C aircraft	160K	30K	100K	
3. MLS/RNAV for CTOL CAT A & B aircraft	160K	15K	100K	
4. MLS/RNAV for CTOL transport CAT C aircraft	160K	15K	100K	
5. MLS curved path for CTOL transport CAT C aircraft	Completed 3/3/1983	Completed 3/3/1983	Funded FY-1983	
6. MLS Category III approach criteria for CTOL aircraft	160K	30K	100K	
7. MLS STOL straight-in criteria up to 8°	160K	38K	100K	

Major Project (Tasks)	Flight Hours	Per Diem	Data Reduction	Contract Engineering Support
3) TERPS (con't)				
8. MLS/RNAV approach criteria for STOL aircraft	160K	38K	100K	
9. MLS curved approach for STOL aircraft	160K	38K	100K	
10. MLS CAT III criteria for STOL aircraft	160K	38K	100K	
11. Rotorcraft discrete airport straight-in and azimuth offset steep angle approach criteria for MLS split sites	Completed 1979	Completed 1979	Funded FY-1981	
12. MLS helicopter approach criteria to a collocated MLS site on a heliport	160K	41K	100K	
13. MLS helicopter full capability complex (curved) approach	Provided by NASA AMES	22.6K	100K	
14. MLS helicopter CAT III straight-in steep angle approach criteria	160K	15K	100K	
15. ICAO, OCP/MLS Working Group		5.5K		
16. IAPA — MLS mathematical models programmed into IAPA		In-house		
17. MLS approach plate charting requirements	Joint FAA/ NOS/DOD	In-house		
18. MLS Publications — AIM and ACS		In-house		
19. MLS Training Program for procedures specialist		In-house		
20. Joint FAA/USAF MLS CAT D & E straight-in offset, RNAV approach criteria	Funded ADL/ADM	Funded ADL/APM	100K	Funded ADL/APM

Major Projects (Tasks)	Flight Hours	Per Diem	Data Reduction	Contract Engineering Support
B) TERPS (con't)				
21. MLS CTOL straight-in transport CAT C aircraft (Turboprop)	160K	15K	100K	
22. Second MLS airborne data acquisition recording system for advance FI/TERPS data collection	200K		100K	
23. Data conversion package	30K			

Table 2 — Resource Requirements

Project Task	Personnel AVS	Flight Hrs.	Per Diem	Engineering Support	Data Reduction	Funding FY-84	Funding FY-85	Fundin FY-86
A. Flight Inspection								
1. Calibration MLS	16 man-days	4.5K	.8K			5.3K		
2. RTT	64 man-days	4.5K	.8K			5.3K		
3. Dev MLS Flt. Insp. Proc., CTOL, STOL, and HELO	520 man-days	486.8K	49K	100K		322K	200.8K	113K
4. Flt. Inspection Training	1 man-year							
5. Directive — FAA Order 8260.XX	1 man-year							
6. Directive — FAA Order 8240.36A	1 man-year							
7. Directive — FAA Order 4040.9	1 man-year							
8. Directive — FAA Order OA P 8200.1	1 man-year							
9. MLS Historical Data	1 man-year							
B. TERPS								
1. CTOL straight-in and Azimuth Offset CAT A & B Aircraft	1.6 man-years	37.5K	8K		100K	145.5K		
2. CTOL straight-in CAT C Aircraft	3.3 man-years	160K	30K		100K	290K		
3. MLS/RNAV CTOL CAT A & B Aircraft	3.3 man-years	160K	15K		100K		100K	175K
4. MLS/RNAV CTOL CAT C Aircraft	3 man-years	160K	15K		100K		100K	175K
5. MLS Curved CTOL CAT C Aircraft	6.5 man-years	Completed	Completed		Funded FY-83			

Table 2 — Resource Requirements (Continued)

Project (Task)	Personnel AVS	Flight Hrs.	Per. Diem	Engineering Support	Data Reduction	Funding FY-84	Funding FY-85	Funding FY-86
. TERPS (Con't)								
6. MLS CAT III CTOL	Post 1985	160K	30K		100K			290K
7. MLS STOL straight-in	No program to date	160K	38K		100K		298K	
8. MLS/RNAV STOL	No program to date	160K	38K		100K			298K
9. MLS curved STOL	No program to date	160K	38K		100K			298K
10. MLS CAT III STOL	Post 1985	160K	38K		100K			298K
11. MLS rotorcraft split site	3.3 man-years	Completed 1979	Completed 1979		Funded FY-81			
12. MLS Helicopter Heliport	1.5 man-years	160K	41K		100K	201K	100K	
13. MLS Helicopter Curved	2.2 man-years	Provided by NASA	22.6K		100K	122.6K		
14. MLS Helicopter CAT III	Post 1985	160K	15K		100K			275K
15. ICAO, OCP/MLS Working Group	.4 man-years		5.5K			2K	2K	1.5K
16. IAPA — MLS Programmed	.9 man-years							
17. MLS Charting	1 man-year							
18. MLS Publications	1 man-year							
19. MLS Training Proc.	1 man-year							
20. Joint FAA/USAF MLS CAT D & E Straight-in Offset, RNAV Approach Criteria		Funded ADL/APM	Funded ADL/ APM	Funded ADL/APM	100K		100K	
21. MLS CTOL Straight-in Transport CAT C Aircraft (Turboprop)	3.3 man-year	160K	15K		100K	275K		
22. Second MLS Airborne Data Acquisition Recording System for Advance FI/ TERPS Data Collection	200K			100K		300K		
23. Data Conversion Pkg.	30K					30K		

Summary

	FY-1984		FY-1985	AVS Funded FY-1986	Total
Aircraft/Flt. Hrs.	778.5K		510.8K	1024K	2313.3K
Per Diem/Subject Pilots	140.2K		80K	179.5K	399.7K
Engineering Support	150K		30K	20K	200K
Data Reduction	400K		300K	700K	1400K
2nd Airborne Data Acquisition Recording System Advance FI/TERPS	200K	Funded ADL/APM			
Data Conversion Pkg.	30K	Funded ADL/ADM			
Total	1468.7K		920.8K	1923.5K	4313K

APPENDIX D
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4. FAA Order 7110.65 — Air Traffic Control.
15. FAA Order 7210.3 — Facility Operation and Administration.
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